Section 22 New Hampshire

New Hampshire Route 108 Water Supply Study

December 1988

US Army Corps
of Engineers
New England Division

NEW HAMPSHIRE
ROUTE 108
WATER SUPPLY STUDY

PREPARED FOR

STATE OF NEW HAMPSHIRE

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

December 1988

EXECUTIVE SUMMARY

This report was requested by the New Hampshire Department of Environmental Services to provide them with a basis for evaluating the concept of providing a regional water supply along Route 108. The communities included in the study area were Exeter, Stratham, Newfields, Newmarket, Durham, Madbury, Dover, and Somersworth.

Information is presented on the existing systems in the study communities and preliminary estimates of future water deficits are projected for 2010. Water supply deficits in the year 2010 for the study area towns were estimated as the difference between the projected 2010 average day demand and the reported capacity of the existing systems. The total deficit in the study area used for planning purposes was approximately 4 mgd.

The water supply alternative described in this report is a pipeline along Route 108 with the Lamprey River as the water supply source. In order to develop the Lamprey River as a regional water supply source investigation into reservoir storage, the minimum streamflow requirements, and water treatment would be required. A water supply pipeline along Route 108 as described in this report would have no available elevation head. Thus water would need to be pumped to the communities in the study area.

In order to select the best plan for future water supply, the costs and environmental impacts of several alternatives should be evaluated such as water conservation, repair of existing infrastructure to decrease system leakage, development of local groundwater sources, and development of other surface water sources.

Before a water supply feasibility study is undertaken the Department of Environmental Services and the municipal water supply agencies in the study area communities should develop a policy statement agreeing to jointly investigate and implement the best plan for future water supply.

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Average Day Demand. A communities total water use for the year divided by the number of days in the year.

Cubic Feet per Second (cfs). Unit of measurement for water flow in a stream or pipe.

Gallons per Capita per Day (gpcd). Water use per person per day. May include residential, commercial, industrial, and unaccounted for water use.

Million Gallons per Day (mgd). Unit of measurement for rate of water use.

Million Gallons (mg). Unit of measurement for volume of water.

National Geodetic Vertical Datum (NGVD). Mean Sea level datum of 1929.

Pounds per square inch (psi). Unit of measurement for water pressure.

Safe Yield. The maximum daily quantity of water which can be guaranteed during a critical dry period. The critical period is often taken as the lowest natural flow on record for the stream. With storage a flow approaching the mean annual flow may be developed providing it is economically, environmentally, and technically feasible.

I. INTRODUCTION

STUDY AUTHORITY

Authority for this study is contained in Section 22, Public Law 93-251 as amended, "Planning Assistance to States" which authorizes cooperation with the states in the preparation of plans for the development, utilization, and conservation of water and related resources.

STUDY PURPOSE

The New Hampshire, Department of Environmental Services (DES) requested the Route 108 water supply study to provide them with preliminary information on a water supply pipeline along route 108. This information is to be used as part of their overall regional water supply planning effort and will help them in future decision making. The New Hampshire DES is in favor of regionalizing water supply systems in this area because of projected population growth and increased water demands, operational problems with small private systems, and potential chemical contamination of existing groundwater supplies. The Public Utilities Commission in New Hampshire is beginning to work on a regional planning study which will examine the political aspects of interconnecting New Hampshire communities.

STUDY SCOPE

This is a planning study for the purpose of providing preliminary information that will help in future decision making. This study reports on the concept of providing a regional water supply system from Exeter to Somersworth with the pipes following the Route 108 alignment. The eight communities along Route 108 included in the study area are Exeter, Stratham, Newfields, Newmarket, Durham, Madbury, Dover, and Somersworth. The scope of the study was developed after meetings and telephone contact with DES personnel, local water supply officials, and other interested parties to obtain information and discuss the concept of a regional water supply system.

Planning a regional water supply requires:

- an analysis of projected future water deficit in the study communities;
- an identification of regional sources of water;
- an investigation of the safe yield of that source;
- design of a water treatment plant;

- design of a water supply pipeline;
- and consideration of connections to existing water supply systems.

This report addresses the following issues:

- an identification and description of existing municipal water supply systems in the study communities;
- a preliminary estimate of the future need for additional water supply in the year 2010;
- a discussion of one source of water;
- and preliminary design considerations for a pipeline.

The issues of water treatment plant design and impacts associated with the project are not addressed.

The New Hampshire Department of Environmental Services was also interested in the concept of interconnecting the towns by installing piping between each of the study area towns to service local needs. However developing the hydraulics and economics for this alternative was beyond the scope of this study.

OTHER STUDIES

Past studies prepared by the Army Corps of Engineers for the State of New Hampshire on the issues of water supply and hydrology include the following reports:

"Southeast New Hampshire Water Supply Study, Estimated Demands and Resource Availability", July 1976;

"Magnitude and Frequency of Low Streamflows in New Hampshire", December, 1980;

"Southeastern New Hampshire Water Resources Study, Feasibility Report", August 1982;

"Guidance for Estimating Reservoir Yields", December 1986;

"Inventory of Potential Reservoir Sites State of New Hampshire", March 1987.

The "Southeast New Hampshire Water Supply Study" report examines the future water supply need of communities in the seacoast region of New Hampshire

The "Magnitude and Frequency of Low Streamflows in New Hampshire" report includes an analysis of streamflow data to determine low flow frequencies and durations for ungaged streams. The report also identified existing water resources projects having significant effects on low flows.

The "Southeastern New Hampshire Water Resources Study, Feasibility Report" examines the water supply needs in fifty Southeastern New Hampshire communities and suggests potential reservoir sites and groundwater aquifers that could be developed to meet the needs of the study area.

The "Guidance for Estimating Reservoir Yields" report presents a review and analysis of reservoir storage yield relationships for watersheds in New Hampshire. The developed storage yield relationship should serve as a guide for performing preliminary assessments of reservoir sites.

The "Inventory of Potential Reservoir Sites State of New Hampshire" report provides an inventory of potential reservoir sites which had been previously studied by the Corps of Engineers and the Soil Conservation Service. This data base was compiled to provide a listing of potential sites for water supply, flood control, and recreation.

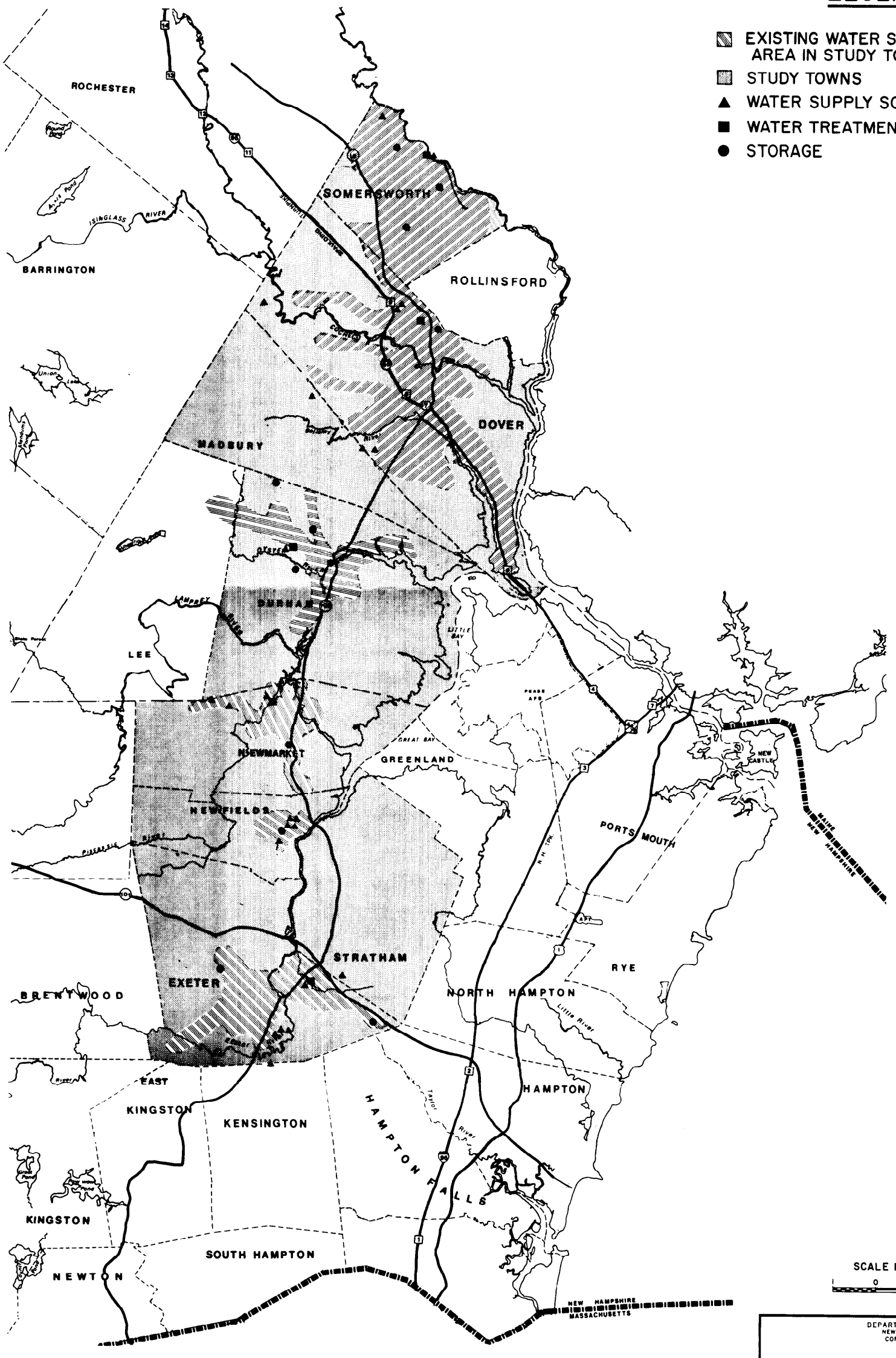
II. EXISTING CONDITIONS

MUNICIPAL WATER SUPPLIES

In this study, the existing water supply facilities in eight communities along Route 108 were examined. The towns of Dover, Durham, Exeter, Newfields, Newmarket, and Somersworth have existing municipal water supply systems. The towns of Madbury and Stratham do not have existing municipal water supply systems. An existing systems map for the study area is provided in Plate 1.

Information on the existing systems in the study area communities was obtained from the report entitled "Public Water Supplies, Facilities, and Policy Summary" (New Hampshire Water Supply and Pollution Control Commission, 1983), from a review of 1986 inventory sheets submitted to the NH Department of Environmental Services by the water departments, and from communication with the water departments. All elevations reported for the storage tanks are assumed to be relative to the National Geodetic Vertical Datum (NGVD).

Information was compiled on sources of supply and reported yield, water treatment capacity, existing distribution storage and distribution mains, reported average day demand, and estimates of the percent of the community served by the municipal water supply system. For purposes of this report the reported yield of the municipal systems were assumed to be the safe yield of these systems. Generally safe yield is the reliability of the system to deliver a specified flow under the most adverse dry weather conditions to be expected. The percent of a community served by the municipal water supply system was estimated by dividing the reported service population by the total population. Where the service population was not reported it was estimated by multiplying the number of service connections by 3.2 persons per service connection.



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

NEW HAMPSHIRE ROUTE 108 WATER SUPPLY STUDY

STUDY AREA AND EXISTING FACILITIES

PLATE I

COMMUNITY OF DOVER

Dover relies on groundwater supply consisting of 6 wells. The combined reported yield of the wells is 3.73 million gallons per day (mgd). The distribution system includes a 4 million gallon (mg) distribution storage tank and distribution mains range in size from from 2 to 16 inches. The reported average day demand in 1986 was 2.3 mgd. For purposes of this study it was estimated that 99 percent of the population is served by the system. Dover water works is currently in the process of developing additional ground water supply in an area known as the Hoppers off of Glen Hill Road (8 inch test well in place). The Dover municipal landfill located off of Tolend Road is an identified hazardous waste site approximately 3000 ft south of one of the supply wells. Information on the Dover Water Works is presented in the following table.

TABLE 1
DOVER WATER WORKS

SOURCES OF SUPPLY	REPORTED YIELD(MGD)
1.GP CUMMINGS	0.5
2.GP IRELAND	0.8
3.GP GRIFFIN	0.75
4.GP CALDERWOOD	0.85
5.GP HUGHES	0.43
6. SMITH	0.4
TOTAL	3.73

TREATMENT OF SOURCES	REPORTED CAPACITY(MGD)
1. GP CUMMINGS	0.85
2. SMITH	
KMnO4 addition, pressure filtration	

DISTRIBUTION STORAGE	
1.GARRISON HILL RESERVOIR	
CAPACITY(MG):	4
FOUNDATION ELEV.(FT):	272
OVERFLOW ELEV.(FT):	305

DISTRIBUTION MAINS

TYPE OF PIPE: DUCTILE IRON AND CEMENT ASBESTOS
MINIMUM PIPE SIZE(INCH): 2
MAXIMUM PIPE SIZE(INCH): 16

COMMUNITY OF DURHAM

The town of Durham relies on surface and groundwater sources. The University of New Hampshire (UNH) owns and operates the water treatment plant and pumps water from the Oyster River to supply the University and municipal distribution system. Water is infrequently pumped from the Lamprey River to the Oyster River for fire fighting purposes, pump capacity not known (pers comm., UNH water treatment plant, 1988). For purposes of this study the existing treatment plant capacity of 1.4 mgd was taken as the amount of water the system could be expected to supply on an average daily basis. The distribution system includes three storage tanks with a combined capacity of 4.6 mg and the distribution mains range in size from 2 to 12 inches. The reported average day demand in 1986 was 1 mgd. For purposes of this study it was estimated that 61 percent of the population is served by the system. Information on the Durham water works is presented in the following table.

TABLE 2
DURHAM WATER WORKS

SOURCES OF SUPPLY	REPORTED YIELD(MGD)	
1.OYSTER RIVER	1.7	(allowed pumping)
2.LAMPREY RIVER		(fire fighting only)
3.GP WELL IN LEE	0.5	
TOTAL	2.2	
TREATMENT OF SOURCES	**REPORTED CAPACITY(MGD)**	
WATER TREATMENT PLANT	1.4	
Alum, NaOH addition, sedimentation, gravity filtration, NaF, chlorine gas		
DISTRIBUTION STORAGE		
1.EDGEWOOD RD.		
CAPACITY(MG):	1	
OVERFLOW ELEV.(FT):	211.6	
2.FOSS FARM ROAD		
CAPACITY(MG):	3	
OVERFLOW ELEV.(FT):	211.6	
3.BEECH HILL		
CAPACITY(MG):	0.6	
FOUNDATION ELEV.(FT):	278	
OVERFLOW ELEV.(FT):	310	
DISTRIBUTION MAINS		
TYPE OF PIPE: CAST OR DUCTILE IRON		
MINIMUM PIPE SIZE(INCH):	2	
MAXIMUM PIPE SIZE(INCH):	12	

COMMUNITY OF EXETER

Exeter is supplied by surface water and groundwater sources. The total combined yield of these sources is 2.58 mgd. This estimate does not include wells which have been abandoned by the town. The reported capacity of the water treatment plant is 1.8 mgd. Exeter is currently looking into upgrading the existing water treatment plant and bringing the abandoned wells back on line. For purposes of the study the existing treatment plant capacity of 1.8 mgd was taken as the amount of water the system could be expected to supply on an average daily basis. The distribution system consists of 2 storage tanks with a combined capacity of 2 mg and the distribution mains range in size from 4 to 12 inches. The reported average day demand in 1986 was 1 mgd. For purposes of this study it was estimated that 90 percent of the population is served by the system. Information on the Exeter Water Department is presented in the following table.

TABLE 3
EXETER WATER DEPARTMENT

SOURCES OF SUPPLY	REPORTED YIELD(MGD)	
1.DEARBORN BROOK	0.5	
2.EXETER RIVER	2	(2.5 PUMP CAP.)
3.SKINNER SPRING WELL	0.08	
TOTAL	2.58	

TREATMENT OF SOURCES:	REPORTED CAPACITY(MGD)
WATER TREATMENT PLANT	1.8
KMnO4, Alum, Na-aluminate, NaOH addition, tube settlers, gravity filtration, hypochlorite.	

DISTRIBUTION STORAGE	
1.FULLER LANE	
CAPACITY(MG):	1
OVERFLOW ELEV.(FT):	140
2.EPPING ROAD	
CAPACITY(MG):	1
OVERFLOW ELEV.(FT):	140

DISTRIBUTION MAINS	
TYPE OF PIPE: CAST OR DUCTILE IRON	
MINIMUM PIPE SIZE(INCH):	4
MAXIMUM PIPE SIZE(INCH):	12

COMMUNITY OF NEWFIELDS

Newfields is supplied by groundwater sources. The total combined reported yield of the wells is approximately 0.14 mgd. The distribution storage includes one storage tank with a capacity of 0.207 mg and the distribution mains range in size from 4 to 12 inches. The reported average day demand in 1986 was 0.04 mgd. For purposes of this study it was estimated that 59 percent of the population is served by the system. Information on the Newfields Water Department is presented in the following table.

TABLE 4
NEWFIELDS WATER DEPARTMENT

SOURCES OF SUPPLY	REPORTED YIELD(MGD)
1.GP #1	0.030
2.GP #2 AND #4	0.049
3.BR #3	0.022 (1)
4.BR AT PS	0.034
TOTAL	0.135
TREATMENT OF SOURCES	**REPORTED CAPACITY(MGD)**
WATER AT WELLS BEING AUTOMATICALLY CHLORINATED	
DISTRIBUTION STORAGE	
1.MAIN ST.	
CAPACITY(MG):	0.207
OVERFLOW ELEV.(FT):	179
DISTRIBUTION MAINS	
TYPE OF PIPE: DUCTILE IRON, ASBESTOS CEMENT, PLASTIC	
MINIMUM PIPE SIZE(INCH):	4
MAXIMUM PIPE SIZE(INCH):	12

(1) Since this information was compiled Bedrock well #3 has been shut down due to contamination (pers. comm. NH DES, 1988).

COMMUNITY OF NEWMARKET

Newmarket is supplied by surface and groundwater sources. The two surface water sources are the Picassic River and Follet's Brook. When flow in the brook is low water can be pumped from a well into the brook. Water from these sources is treated at the water treatment plant. Combined reported yield of these sources is 0.79 mgd. In addition there are two wells that feed directly into the distribution system with a combined yield of 0.46 mgd. The distribution storage includes one storage tank with a capacity of 0.75 mg and the distribution mains range in size from 2 to 14 inches. The reported demand in 1986 was 0.5 mgd. For purposes of this study it was estimated that 60 percent of the population is served by the system. The town of Newmarket expects to have a new water treatment plant in 3 to 5 years. Information on the Newmarket Water Works is presented in the following table.

TABLE 5
NEWMARKET WATER WORKS

SOURCES OF SUPPLY	REPORTED YIELD(MGD)	
1.FOLLETT'S BROOK		
2.FOLLETT'S BROOK WELL	0.07	(PUMPS INTO BROOK)
3.PISCASSIC RIVER		
COMBINED YIELD OF #1,2,3	0.79	
4.BENNET RTE 152 WELL	0.23	
5.SEWALL WELL	0.23	
TOTAL	1.25	

TREATMENT OF SOURCES	REPORTED CAPACITY(MGD)
WATER TREATMENT PLANT	0.79
Alum, lime, gravity filtration, hypochlorite	

DISTRIBUTION STORAGE	
1.GREAT HILL	
CAPACITY(MG):	0.75
FOUNDATION ELEV.:	199
OVERFLOW ELEV.(FT):	257

DISTRIBUTION MAINS	
TYPE OF PIPE: CAST OR DUCTILE IRON	
MINIMUM PIPE SIZE(INCH):	2
MAXIMUM PIPE SIZE(INCH):	14

COMMUNITY OF SOMERSWORTH

Somersworth is supplied by surface and groundwater sources. The surface water source is the Salmon Falls River with a reported yield of 1 mgd. The treatment plant has a reported capacity of 1.2 mgd. There are two wells in use in the Lily Pond aquifer with a reported yield of 0.7 mgd. The distribution storage includes two storage tanks with a combined capacity of 2 mg and the distribution mains range in size from 4 to 16 inches. The reported average day demand in 1986 was 1.22 mgd. For purposes of this study it was estimated that 98 percent of the population is served by the system. The Somersworth municipal landfill located off of Blackwater Road is an identified hazardous waste site. Information on the Somersworth Water Works is presented in Table 6.

TABLE 6
SOMERSWORTH WATER WORKS

SOURCES OF SUPPLY	REPORTED YIELD(MGD)
1.GP #1 & #2	0.7
2.SALMON FALLS RIVER	1
TOTAL	1.7

TREATMENT OF SOURCES	REPORTED CAPACITY(MGD)
WATER TREATMENT PLANT	1.2
polymers, Na-aluminate, KMnO4, Alum, activated carbon, tube settlers, filtration, sodium hypochlorite, NaOH	

DISTRIBUTION STORAGE	
1.HAMILTON STREET	
CAPACITY(MG):	1
FOUNDATION ELEV.(FT):	304
OVERFLOW ELEV.(FT):	398
2.ROCKY HILL ROAD	
CAPACITY(MG):	1
FOUNDATION ELEV.(FT):	304
OVERFLOW ELEV.:	398

DISTRIBUTION MAINS	
TYPE OF PIPE:	DUCTILE IRON
MINIMUM PIPE SIZE(INCH):	4
MAXIMUM PIPE SIZE(INCH):	16

III. REGIONAL WATER SUPPLY ANALYSIS

In order to project the water deficit for the study communities in the year 2010, population projections and an estimate of future rate of water use in gallons per capita per day are required.

POPULATION PROJECTIONS

Population in the study area communities is expected to increase. Data on existing and projected population for the communities in the study area was obtained from the New Hampshire Office of State Planning. Table 7 contains the population projections for each community to the year 2010. The percent change from 1986 to 2010 is expected to range from an low of 43 percent for the community of Dover to a high of 117 percent for the community of Stratham. This expected increase in population will result in increased water supply demands on the existing municipal systems.

TABLE 7

POPULATION GROWTH FOR STUDY COMMUNITIES

Community	1986	1990	2000	2010	% Change 1986-2010
DOVER	24053	25838	30534	35443	47
DURHAM	11358	12562	14586	16216	43
EXETER	11846	14577	19571	25703	117
NEWFIELDS	846	1036	1330	1679	98
NEWMARKET	6497	6371	7983	10137	56
SOMERSWORTH	10572	11762	14176	16654	58
MADBURY	1130	1296	1658	1990	76
STRATHAM	3520	4122	5992	7522	114

GALLONS PER CAPITA PER DAY PROJECTIONS

The concept of per capita water demand allows for a gross estimate of the water supply needs of an area. This rate varies from community to community, is related to type of land use and standard of living, and generally shows an increasing trend over time. Data was available on the average daily demand and service population for 1983 and 1986. From this data the best estimate of the existing rate of water use was calculated; and is shown in Table 8. The water use rates calculated for the study area communities ranged from 78 gallons per capita per day (gpcd) for Newfields to 136 gpcd for Durham.

TABLE 8
EXISTING WATER USE

	1983		1986		
Community	Service Population	Ave. Day Demand (mgd)	Service Population	Ave. Day Demand (mgd)	Estimated GPCD
DOVER	21300	2.100	25300	2.300	95
DURHAM	7000	0.928	7123	1.000	136
EXETER	11000	0.907	10000	1.000	91
NEWFIELDS	474	0.035	506	0.042	78
NEWMARKET	2800	0.228	3936	0.500	104
SOMERSWORT	10100	1.300	10500	1.223	123
MADBURY	0	0	0	0	105
STRATHAM	0	0	0	0	105

Estimates of gallons per capita per day contained in this report must be regarded as preliminary. A detailed study of water use in each community would be required to improve the accuracy of these estimates. These estimates of gpcd include residential, commercial, public, industrial, and unaccounted water demand on the existing systems. Average annual use for eastern regions of the United States ranges from 64 to 238 gpcd.

WATER DEMAND PROJECTIONS

The above estimates of the gpcd and the future population in each community were used to calculate the average day demand on a community's water system in the year 2010. The 2010 water supply deficit in a community was estimated as the difference between the average day demand and the existing reported supply. Three different cases were projected.

Case I assumed per capita water use (gpcd) and the percentage of the population served in the communities would remain the same. Case I projections are presented in Table 9.

TABLE 9
CASE I. 2010 AVERAGE DAY DEMAND DEFICIT

ASSUME: PERCENT SERVED REMAINS CONSTANT
GPCD REMAINS CONSTANT

COMMUNITY	2010 POP.	PERCENT SERVED	USE RATE (GPCD)	2010 DEMAND (MGD)	REPORTED SUPPLY (MGD)	2010 DEFICIT (MGD)
DOVER	35443	99	95	3.34	3.73	0.00
DURHAM	16216	61	136	1.35	1.40	0.00
EXETER	25703	90	91	2.10	1.80	0.30
NEWFIELDS	1679	59	78	0.08	0.14	0.00
NEWMARKET	10137	60	104	0.63	1.25	0.00
SOMERSWORTH	16654	98	123	2.01	1.70	0.31
MADBURY	1990	0	105	0.00	0.00	0.00
STRATHAM	7522	0	105	0.00	0.00	0.00
TOTAL				9.51	10.02	0.61

Case I shows the increase in water demand when the only parameter driving increased demand is population growth. Under this scenario there would be little need for a regional water supply system to meet the projected deficit.

Case II assumed per capita water use would remain constant, and the percentage of the population served in the community by the municipal system would increase to 100 percent.

TABLE 10
CASE II. 2010 AVERAGE DAY DEMAND DEFICIT

ASSUME: PERCENT SERVED INCREASES
GPCD REMAINS CONSTANT

COMMUNITY	2010 POP.	PERCENT SERVED	USE RATE (GPCD)	2010 DEMAND (MGD)	REPORTED SUPPLY (MGD)	2010 DEFICIT (MGD)
DOVER	35443	100	95	3.37	3.73	0.00
DURHAM	16216	100	136	2.21	1.40	0.81
EXETER	25703	100	91	2.34	1.80	0.54
NEWFIELDS	1679	100	78	0.13	0.14	0.00
NEWMARKET	10137	100	104	1.05	1.25	0.00
SOMERSWORTH	16654	100	123	2.05	1.70	0.35
MADBURY	1990	100	105	0.21	0.00	0.21
STRATHAM	7522	100	105	0.79	0.00	0.79
TOTAL				12.15	10.02	2.70

Under this scenario the communities of Durham, Exeter, Somersworth, Madbury, and Stratham would need additional water supply by the year 2010.

Case III assumed both the service area in each community would expand and the water use rate would increase. It is expected that some increase in gpcd will occur over the study period as historically there has been an increasing trend in gpcd in the study area. It is assumed that per capita water use would increase by 15 percent over the study period. Case III projections are presented in Table 11.

TABLE 11
CASE III. 2010 AVERAGE DAY DEMAND DEFICIT

ASSUME: PERCENT SERVED INCREASES
GPCD INCREASES

COMMUNITY	2010 POP.	PERCENT SERVED	USE RATE (GPCD)	2010 DEMAND (MGD)	REPORTED SUPPLY (MGD)	2010 DEFICIT (MGD)
DOVER	35443	100	109	3.86	3.73	0.13
DURHAM	16216	100	156	2.53	1.40	1.13
EXETER	25703	100	105	2.70	1.80	0.90
NEWFIELDS	1679	100	90	0.15	0.14	0.01
NEWMARKET	10137	100	120	1.22	1.25	0.00
SOMERSWORTH	16654	100	141	2.35	1.70	0.65
MADBURY	1990	100	120	0.24	0.00	0.24
STRATHAM	7522	100	120	0.90	0.00	0.90
TOTAL				13.95	10.02	3.96

Under this scenario seven of the eight communities in the study area would require additional water supply in 2010. The total projected deficit is approximately 4 mgd. These average day demand deficits and a factor of 2, to account for higher maximum day flows, were utilized when estimating pipe capacity along Route 108. A factor of 2 was chosen based on an examination of the literature and on maximum to average day ratios reported for the study communities.

BENEFITS OF A REGIONAL WATER SUPPLY CONCEPT

Benefits of constructing a regional water supply system include the following:

- The ability to supply water to existing municipal systems which may face future water need because of population growth, increased service area, increased water use rate, and possible loss of existing supplies to contamination.

- Encouragement to a community without an existing municipal system to develop the necessary infrastructure to supply water to residents and businesses.

- The redundancy offered to a community, where they would have access to a water supply pipeline if a portion of their supplies failed through a contamination incident or some other incident such as mechanical failure of the well pumps, or clogging of intake screens.

- The mechanical reliability and water quality reliability of a regional system with a full time staff is likely to be better than in smaller scattered systems set up to service residential or commercial developments.

The operational and engineering characteristics of a regional water supply system would require an agency or municipality to take a lead role in implementation and a full time staff to operate the system. In discussions with the New Hampshire Department of Environmental Services (DES) it was not clear where funding for this type of project would come from. However, it was suggested by the DES that management setup and funding would be determined by the local supporters of this regional system. They also suggested that a community which needs to upgrade its water treatment system to meet the proposed Federal Safe Drinking Water Standards may realize some cost benefits in building a larger capacity water treatment plant and then selling excess water to adjacent communities.

SOURCE OF WATER

Analysis of the concept of a water supply pipeline along Route 108 required identification of additional components of the regional water supply system including the source of supply. The New Hampshire Department of Environmental Services suggested for the purposes of this report that the Lamprey River at Newmarket be considered as the source of supply. The issue of water treatment is not addressed in this study but treatment would be required if the Lamprey River were to be chosen as a source of supply.

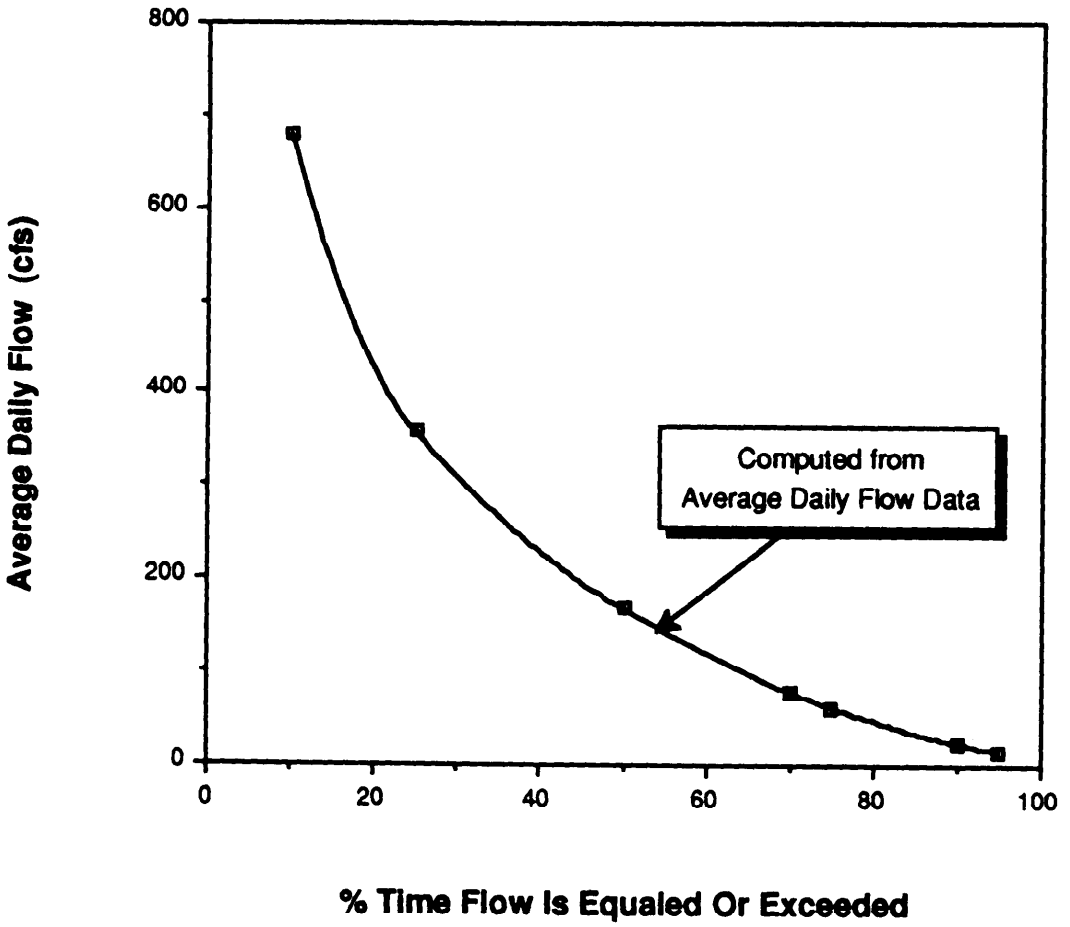
In order to estimate the amount of water available from the Lamprey River for water supply purposes flow records for the nearest gage were examined. There is a stream gage on the Lamprey River approximately 2 miles northwest of Newmarket. The drainage area of the Lamprey River at Newmarket is approximately 208 square miles. The drainage area at the gage location is 183 square miles. Data from this gage were used. Daily flow data for the Lamprey at the gage are presented in Figure 1. The median daily flow in the Lamprey River at the gage is about 168 cfs (109 mgd).

However, for water supply purposes, without reservoir storage, the river low flows should be examined to estimate the safe yield of the river. The period of flow record used was 1936-1985. For purposes of this study, the source would be considered safe or reliable if in a one in 50 year return interval (2 percent chance of occurrence) water would still be available for supply. The annual minimum flows for 1 day and 7 day durations were fitted to a log Pearson type III probability distribution (USGS 1987). Percent chance of occurrence for 1 day and 7 day durations are presented in Figure 2. Based on these data and considering the 7 day duration, 50 year return interval, the safe yield of the river would be 3.4 cfs (2.2 mgd). The average daily demand deficit in the year 2010 that this alternative would be required to supply is estimated at approximately 4 mgd (6.2 cfs). Thus, it is anticipated that the natural stream flows at the intake may, at times, be inadequate and a storage scheme of some sort would be required.

In addition, when estimating the reliable supply of the river it should be recognized that there may be water supply withdrawal constraints imposed by State agencies to protect instream water quality and fish and wildlife considerations. The US Fish and Wildlife Service, in a letter relating to a hydropower development project on the Lamprey River at Newmarket, recommended that flows in the river be maintained at 105 cfs or at the rate of inflow to the project area, which ever is less. If this constraint were in place it would be likely that there would be periods of time each summer when no water withdrawal would be allowed from the river because of these flow constraints. Thus it appears that in order to develop this supply on a continuous basis reservoir storage would be required. No examination was made to determine if adequate storage could be built in the area or whether inflows to such a project would be adequate to supply water demand and instream flow requirements.

FIGURE 1

LAMPREY RIVER FLOW DATA



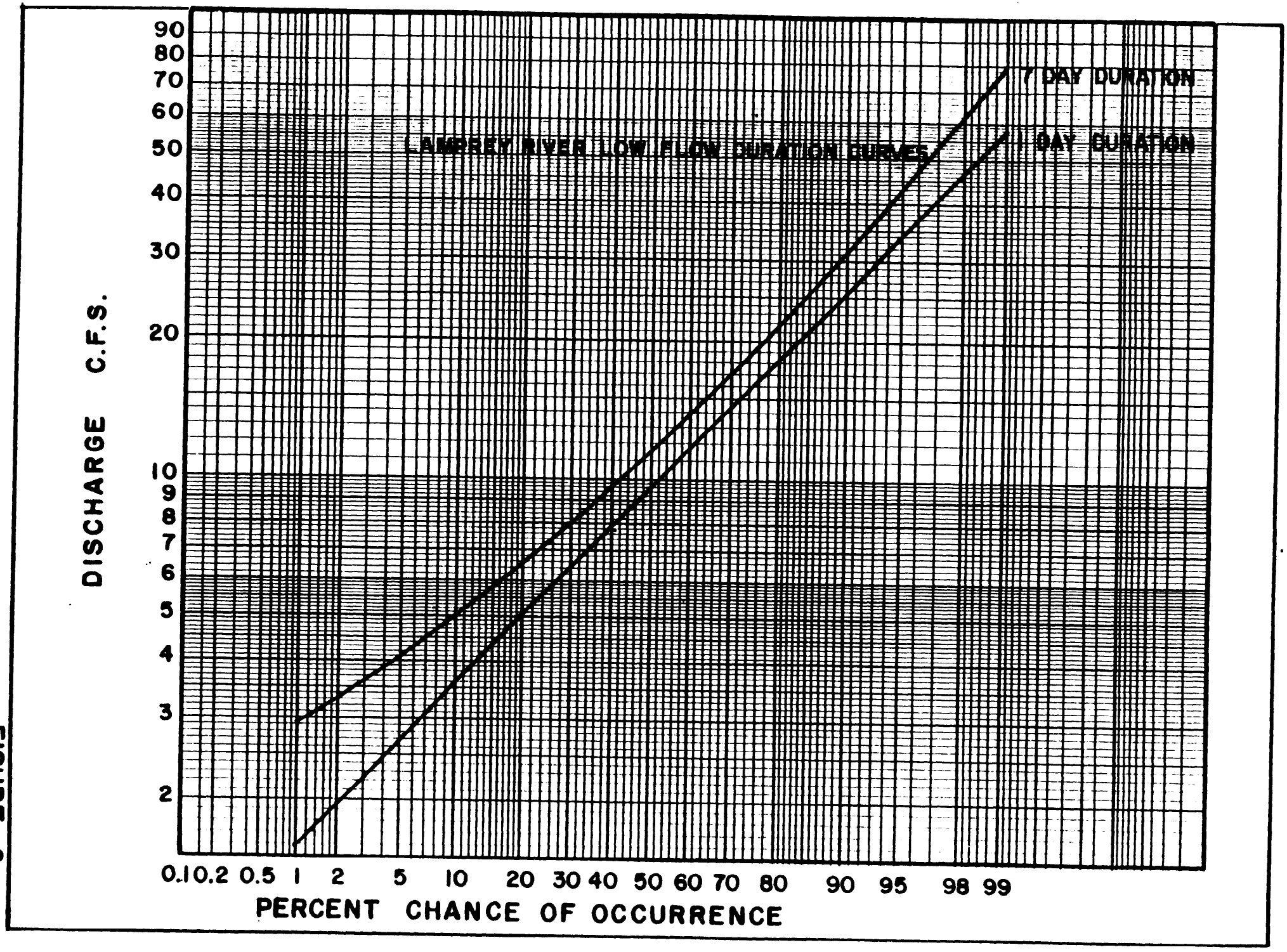

LAMPREY RIVER LOW FLOW DURATION CURVES
7 DAY DURATION
1 DAY DURATION
DISCHARGE C.F.S.
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99
PERCENT CHANCE OF OCCURRENCE

FIGURE 2

PRELIMINARY PIPELINE DESIGN

Based on discussions with the NH Department of Environmental Services, it was assumed for purposes of this study that water would be pumped from the Lamprey River to a water treatment plant then into a pipeline along Route 108. The pipeline was broken into a series of mains with each section running from the outlet in one community to the outlet in the next community. The communities would be responsible for providing distribution system extensions, water supply storage, and any additional pumping.

Maintaining adequate water pressures and delivering the desired rate of flow to each community requires appropriately sized pipes as well as adequate provisions for supplying system head either through a gravity system or through pumping. The selection of pipe size and pumping requirements is usually determined based on hydraulic and economic considerations. Cost estimates and pumping requirements provided in this report are for planning purposes only, usually to be used in comparison of alternatives and are not to be used as engineering estimates for the pipeline.

In order to provide preliminary hydraulic and economic estimates a computer program developed by the Environmental Laboratory of the U.S. Army Engineer Waterways Experimental Station called Methodology for Areawide Planning Studies (MAPS) was used (see appendix). The estimates of costs and pumping requirements calculated by the computer program are dependent on the accuracy of the design data assumptions, construction data assumptions, and economic assumptions.

The total length of pipeline required along Route 108 from Dover to Somersworth is approximately 19 miles. Elevations and distances were measured from USGS quadrangles at a scale of 1:24000 with 20 foot contour intervals. All elevations are assumed to be relative NGVD. Outlet locations in each community were selected in order to allow measurement of pipeline sections and to provide points for elevations. Lengths of pipeline sections and elevations at outlets are presented in Table 12.

TABLE 12

PIPE DESIGN INFORMATION

Main No.	Location	Pipe Length (ft)	Elevation Initial (ft)	Elevation Final (ft)	Peak (ft)	Pipe Capacity (mgd)
Main No.1	Lamprey River, Newmarket to, Newfields Outlet	16000	40	40	102	3.62
Main No.2	Newfields to, Stratham Outlet	11200	40	120	na	3.60
Main No.3	Stratham to, Exeter Outlet	10000	120	30	na	1.80
Main No.4	Lamprey River, Newmarket to, Durham Outlet	19800	40	50	85	4.34
Main No.5	Durham Outlet, to Madbury Outlet	12000	50	100	na	2.04
Main No.6	Madbury Outlet, to Dover Outlet	20400	100	140	na	1.56
Main No.7	Dover Outlet, to Somersworth	11800	140	206	na	1.30

Because the Lamprey River at Newmarket is in the middle of the Route 108 study area, water would flow south from the Lamprey River to Newfields, Stratham and Exeter; and north to Durham, Madbury, Dover, and Somersworth. Providing water to each community requires pumping except from the Stratham outlet to the Exeter outlet. Hydraulics that control design are the head available and permissible velocities. Estimates of amount of head required and velocities for pipe diameters of 8 to 24 inches were calculated by MAPS (see appendix). These estimates are based on projected flow to the communities, calculation of head loss through the pipe, changes in elevation along the pipeline, and maintenance of pressure at the outlets (60 psi). A summary of this information for 12, 14, and 16 inch pipe diameters are presented in Table 13 and an elevation profile for Route 108 and the hydraulic grade line for a series of 14 inch pipes is presented in Plate 2. These estimates are for planning purposes. A detailed hydraulic analysis would be required for design specifications.

Estimated capital costs and operation and maintenance costs for pipe diameters of 8 to 24 inches were calculated by MAPS. These capital cost estimates and operation and maintenance cost estimates for pipes and pumps and a description of the assumptions made when calculating the costs are presented in the appendix. These costs are preliminary and should be used for comparative purposes only.

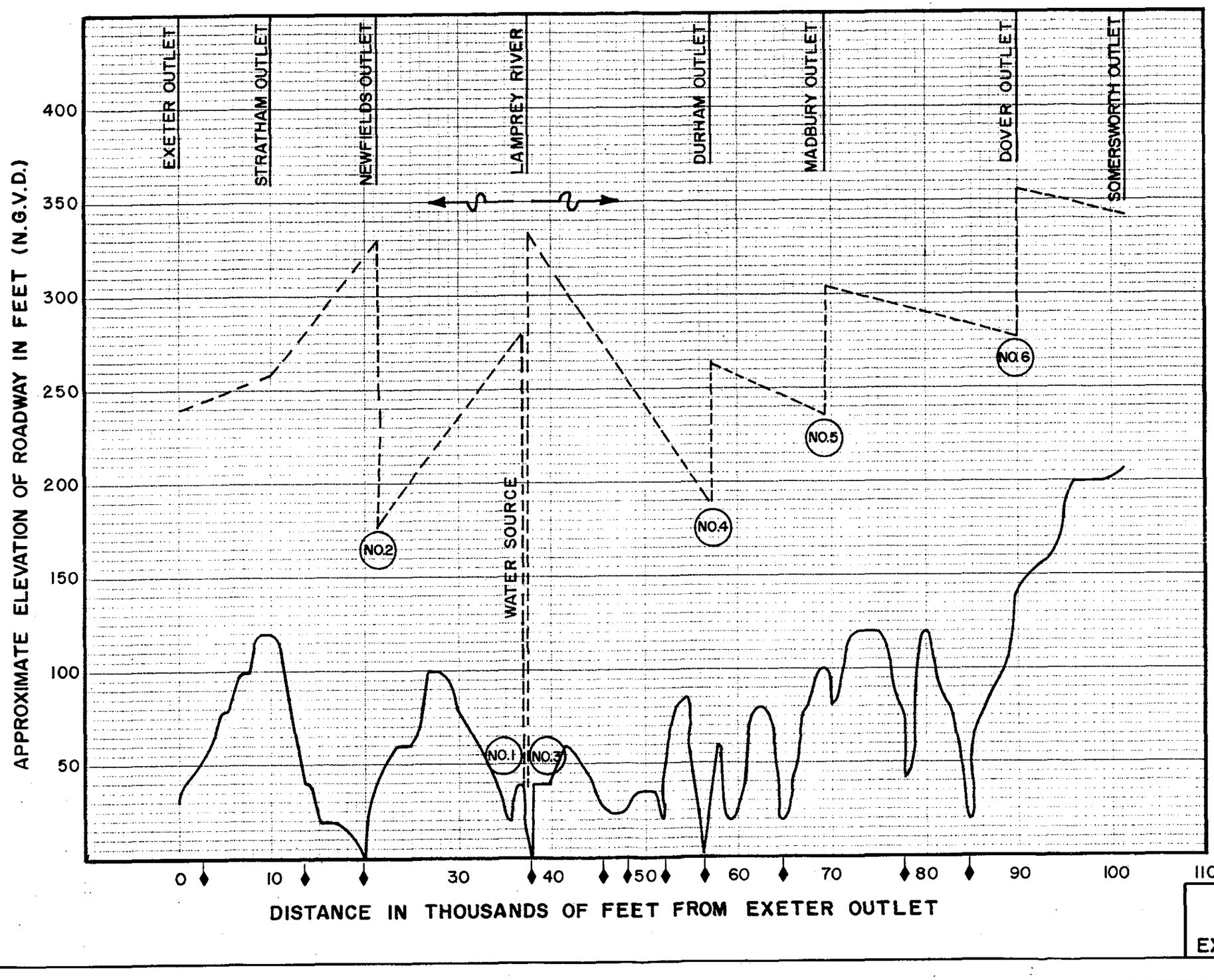
A summary of estimated capital costs for pipe diameters of 12, 14, and 16 inches are presented in Table 14. Operation and maintenance costs are not included in the summary table because MAPS calculates these costs assuming full time operation and maintenance and this may not be the manner in which the system would be operated.

No attempt was made in this report to determine the combination of pipe sizes and pumping requirements that would produce the most economical transmission main.

TABLE 13

HEAD REQUIRED

MAIN NO:	FLOW (MGD)	PIPE DIAM. (IN.)	PIPE LENGTH (FT)	TYPE OF FLOW	HEAD REQ.D (FT)	ESTIMATED VELOCITY (FPS)
1	3.62	12	16000	PUMPED	370	7
1	3.62	14	16000	PUMPED	244	5
1	3.62	16	16000	PUMPED	192	4
2	3.60	12	11200	PUMPED	241	7
2	3.60	14	11200	PUMPED	153	5
2	3.60	16	11200	PUMPED	117	4
3	1.80	12	10000	GRAVITY	0	6
3	1.80	14	10000	GRAVITY	0	6
3	1.80	16	10000	GRAVITY	0	7
4	4.34	12	19800	PUMPED	557	9
4	4.34	14	19800	PUMPED	334	6
4	4.34	16	19800	PUMPED	243	5
5	2.04	12	12000	PUMPED	108	4
5	2.04	14	12000	PUMPED	76	3
5	2.04	16	12000	PUMPED	64	2
6	1.56	12	20400	PUMPED	99	3
6	1.56	14	20400	PUMPED	67	2
6	1.56	16	20400	PUMPED	54	2
7	1.30	12	11800	PUMPED	90	3
7	1.30	14	11800	PUMPED	77	2
7	1.30	16	11800	PUMPED	72	1



ROUTE 108
N.H., PROFILE
EXETER TO SOMERSWORTH

PLATE 2

TABLE 14

CAPITAL COSTS SUMMARY

MAIN NO.	PIPE DIAM. (IN.)	MAIN CAPITAL COSTS ($)	PUMP CAPITAL COSTS ($)	TOTAL CAPITAL COSTS ($)
1	12	$701,000	$394,000	$1,095,000
1	14	$816,000	$350,000	$1,166,000
1	16	$930,000	$329,000	$1,259,000
2	12	$491,000	$348,000	$839,000
2	14	$571,000	$311,000	$882,000
2	16	$651,000	$293,000	$944,000
3	12	$438,000	$0	$438,000
3	14	$510,000	$0	$510,000
3	16	$582,000	$0	$582,000
4	12	$868,000	$500,000	$1,368,000
4	14	$1,010,000	$424,000	$1,434,000
4	16	$1,150,000	$387,000	$1,537,000
5	12	$526,000	$214,000	$740,000
5	14	$612,000	$201,000	$813,000
5	16	$698,000	$196,000	$894,000
6	12	$894,000	$183,000	$1,077,000
6	14	$1,040,000	$172,000	$1,212,000
6	16	$1,190,000	$167,000	$1,357,000
7	12	$517,000	$164,000	$681,000
7	14	$602,000	$160,000	$762,000
7	16	$686,000	$159,000	$845,000

OTHER ALTERNATIVES

The alternative described above should be compared against other water supply options. It may be advisable to choose a source at a different location to provide elevation head for gravity feed. Several other alternatives for this region were previously examined in the "Southeastern New Hampshire Water Resources Study" authorized by Congress in 1976 and completed by the Corps of Engineers in 1982.

The New Hampshire DES has suggested that the communities may want to interconnect with adjacent communities using existing pipes along Route 108 and installing new piping where needed. In order to work towards this alternative the DES suggests that where possible the communities evaluate and match adjacent community hydraulic grade lines when installing future storage.

In addition to structural alternatives to meet future water needs the communities should examine the adoption of water conservation plans.

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APPENDIX

MAPS COMPUTER PROGRAM OUTPUT

METHODOLOGY FOR AREAWIDE PLANNING STUDIES (MAPS)

The MAPS computer program is a tool developed by the Environmental Laboratory of the U.S. Army Engineer Waterways Experimental Station to assist Corps personnel in screening alternative water supply plans. The cost estimates produced by the program are for the purpose of comparing alternatives and are not to be used as engineering cost estimates for the project.

The following construction data was input to the MAPS computer program and is important when estimating pipe costs. It was assumed that the type of pipe used would be ductile iron pipe and that the pipe should be manufactured to withstand a 400 foot peak pressure except in the case of Main 4 where a pressure of 600 foot was used. It was assumed that excavation would be under dry soil conditions. It was assumed that the design life would be 50 years. It was assumed that 20 percent of the excavation would be through rock.

The following economic data was input to the MAPS computer program. The 1987 Engineering News Record construction cost index value of 4400.77 was used to update costs in the program. An operation and maintenance wage rate of $20 per hour was used to calculate operation and maintenance costs. An interest rate of 10 percent was used calculating the average annual cost of construction.

Estimates of pipe costs include the cost of purchasing, hauling, and laying the pipe and is dependent on the diameter, material, length, and the maximum pressure the pipe is manufactured to withstand. The costs involved in "other costs" include excavation, backfill and contingencies. Construction costs are a sum of the pipe costs and other costs. The overhead costs include engineering, interest during construction, legal, fiscal, and administrative costs. These are calculated by MAPS as 25 percent of the construction cost. The estimated capital costs for the mains are the sum of the construction and overhead costs. Land costs, costs of pipe valves, and cost of pipe elbows are not included.

Estimates of pump construction costs include the costs of mechanical equipment, cost for the pump station structure, and "miscellaneous costs" (which includes additional equipment costs and contingencies) multiplied by a design factor of 1.3. The estimated pump capital costs are the sum of the construction and overhead costs. Electrical equipment costs and costs for land are not included.

The estimated annual operation and maintenance costs for the pipes are calculated by MAPS as a function of the capital cost of the pipe. The estimated annual pump operation and maintenance costs are calculated as the sum of power costs, labor costs, and a supply cost factor. These cost estimates assume full time production and operation.

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 1

MAXIMUM FLOW- STAGE 1	0.362E+01	MGD
AVERAGE FLOW- STAGE 1	0.362E+01	MGD
LENGTH	0.160E+05	FT
LENGTH	0.303E+01	MI
INITIAL ELEVATION	0.400E+02	FT
INITIAL PRESSURE HEAD	0.000E+00	FT
FINAL ELEVATION	0.400E+02	FT
FINAL PRESSURE HEAD	0.138E+03	FT
PEAK ELEVATION	0.102E+03	FT
DISTANCE TO PEAK	0.990E+04	FT
ROUGHNESS HEIGHT	0.400E-03	FT
ALLOWABLE PRESSURE IN PIPE	0.400E+03	FT
RECTANGULAR TRENCH		
DEPTH OF COVER	0.300E+01	FT
DRY SOIL CONDITIONS		
ROCK EXCAVATION	0.200E+02	%
TYPE OF PIPE		

DUCTILE IRON PIPE IS USED FOR ALL DIAMETERS

HYDRAULIC ANALYSIS AT PEAK FLOW (FIRST STAGE)
5.600 CFS 3.620 MGD

DIAM (IN)	VELOCITY (FPS)	VELOCITY HEAD (FT)	MINOR LOSSES (FT)	FRICTION LOSSES (FT)	HEAD REQUIRED (FT)
8.0	0.160E+02	0.400E+01	0.000E+00	0.185E+04	0.199E+04
10.0	0.103E+02	0.164E+01	0.000E+00	0.589E+03	0.727E+03
12.0	0.713E+01	0.790E+00	0.000E+00	0.232E+03	0.370E+03
14.0	0.524E+01	0.427E+00	0.000E+00	0.106E+03	0.244E+03
16.0	0.401E+01	0.250E+00	0.000E+00	0.540E+02	0.192E+03
18.0	0.317E+01	0.156E+00	0.000E+00	0.298E+02	0.168E+03
20.0	0.257E+01	0.102E+00	0.000E+00	0.176E+02	0.156E+03
22.0	0.212E+01	0.699E-01	0.000E+00	0.109E+02	0.149E+03
24.0	0.178E+01	0.494E-01	0.000E+00	0.708E+01	0.145E+03

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 1		
CONSTRUCTION YEAR-STAGE 1	1990	
INTEREST RATE	10.000	%
DESIGN LIFE	50	YEARS
ENR CONSTRUCTION INDEX	4400.7	
LAND COST	0.000E+00	$
CITY MULTIPLIER	1.000	
TERRAIN TYPE--		

DIAM (IN)	PIPE COSTS ($)	OTHER COSTS ($)	CONSTRUCTION COSTS ($)	OVERHEAD COSTS ($)	OPERATION & MAINT. ($/YR)
8.0	0.2942E+06	0.8422E+05	0.3784E+06	0.9459E+05	0.1512E+04
10.0	0.3674E+06	0.1023E+06	0.4697E+06	0.1174E+06	0.1679E+04
12.0	0.4405E+06	0.1206E+06	0.5611E+06	0.1403E+06	0.1848E+04
14.0	0.5136E+06	0.1391E+06	0.6527E+06	0.1632E+06	0.2019E+04
16.0	0.5866E+06	0.1578E+06	0.7444E+06	0.1861E+06	0.2190E+04
18.0	0.6795E+06	0.1806E+06	0.8601E+06	0.2150E+06	0.2430E+04
20.0	0.7959E+06	0.2083E+06	0.1004E+07	0.2511E+06	0.2743E+04
22.0	0.9183E+06	0.2375E+06	0.1156E+07	0.2889E+06	0.3068E+04
24.0	0.1046E+07	0.2824E+06	0.1329E+07	0.3322E+06	0.3442E+04

FORCE MAIN COST SUMMARY
MOD NO. 1

DIAM (IN)	CAPITAL COST ($)	O&M COST ($/YR)	AVERAGE ANNUAL COST ($/YR)
8.0	0.473E+06	0.151E+04	0.492E+05
10.0	0.587E+06	0.168E+04	0.609E+05
12.0	0.701E+06	0.185E+04	0.726E+05
14.0	0.816E+06	0.202E+04	0.843E+05
16.0	0.930E+06	0.219E+04	0.960E+05
18.0	0.108E+07	0.243E+04	0.111E+06
20.0	0.126E+07	0.274E+04	0.129E+06
22.0	0.144E+07	0.307E+04	0.149E+06
24.0	0.166E+07	0.344E+04	0.171E+06

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 2		
MAXIMUM FLOW- STAGE 1	0.360E+01	MGD
AVERAGE FLOW- STAGE 1	0.360E+01	MGD
LENGTH	0.112E+05	FT
LENGTH	0.212E+01	MI
INITIAL ELEVATION	0.400E+02	FT
INITIAL PRESSURE HEAD	0.138E+03	FT
FINAL ELEVATION	0.120E+03	FT
FINAL PRESSURE HEAD	0.138E+03	FT
ROUGHNESS HEIGHT	0.400E-03	FT
ALLOWABLE PRESSURE IN PIPE	0.400E+03	FT
RECTANGULAR TRENCH		
DEPTH OF COVER	0.300E+01	FT
DRY SOIL CONDITIONS		
ROCK EXCAVATION	0.200E+02	%
TYPE OF PIPE		
DUCTILE IRON PIPE IS USED FOR ALL DIAMETERS		

HYDRAULIC ANALYSIS AT PEAK FLOW (FIRST STAGE)
5.569 CFS 3.600 MGD

DIAM (IN)	VELOCITY (FPS)	VELOCITY HEAD (FT)	MINOR LOSSES (FT)	FRICTION LOSSES (FT)	HEAD REQUIRED (FT)
8.0	0.160E+02	0.396E+01	0.000E+00	0.128E+04	0.136E+04
10.0	0.102E+02	0.162E+01	0.000E+00	0.408E+03	0.488E+03
12.0	0.709E+01	0.781E+00	0.000E+00	0.161E+03	0.241E+03
14.0	0.521E+01	0.422E+00	0.000E+00	0.735E+02	0.153E+03
16.0	0.399E+01	0.247E+00	0.000E+00	0.374E+02	0.117E+03
18.0	0.315E+01	0.154E+00	0.000E+00	0.207E+02	0.101E+03
20.0	0.255E+01	0.101E+00	0.000E+00	0.122E+02	0.922E+02
22.0	0.211E+01	0.692E-01	0.000E+00	0.757E+01	0.876E+02
24.0	0.177E+01	0.488E-01	0.000E+00	0.490E+01	0.849E+02

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 2

CONSTRUCTION YEAR-STAGE 1	1990	
INTEREST RATE	10.000	%
DESIGN LIFE	50	YEARS
ENR CONSTRUCTION INDEX	4400.7	
LAND COST	0.000E+00	$
CITY MULTIPLIER	1.000	
TERRAIN TYPE--		

DIAM (IN)	PIPE COSTS ($)	OTHER COSTS ($)	CONSTRUCTION COSTS ($)	OVERHEAD COSTS ($)	OPERATION & MAINT. ($/YR)
8.0	0.2059E+06	0.5895E+05	0.2649E+06	0.6622E+05	0.1059E+04
10.0	0.2571E+06	0.7162E+05	0.3288E+06	0.8219E+05	0.1175E+04
12.0	0.3083E+06	0.8442E+05	0.3928E+06	0.9819E+05	0.1294E+04
14.0	0.3595E+06	0.9736E+05	0.4569E+06	0.1142E+06	0.1413E+04
16.0	0.4106E+06	0.1104E+06	0.5211E+06	0.1303E+06	0.1533E+04
18.0	0.4756E+06	0.1264E+06	0.6021E+06	0.1505E+06	0.1701E+04
20.0	0.5571E+06	0.1458E+06	0.7030E+06	0.1757E+06	0.1920E+04
22.0	0.6428E+06	0.1662E+06	0.8091E+06	0.2023E+06	0.2148E+04
24.0	0.7325E+06	0.1977E+06	0.9302E+06	0.2325E+06	0.2410E+04

FORCE MAIN COST SUMMARY
MOD NO. 2

DIAM (IN)	CAPITAL COST ($)	O&M COST ($/YR)	AVERAGE ANNUAL COST ($/YR)
8.0	0.331E+06	0.106E+04	0.345E+05
10.0	0.411E+06	0.118E+04	0.426E+05
12.0	0.491E+06	0.129E+04	0.508E+05
14.0	0.571E+06	0.141E+04	0.590E+05
16.0	0.651E+06	0.153E+04	0.672E+05
18.0	0.753E+06	0.170E+04	0.776E+05
20.0	0.879E+06	0.192E+04	0.905E+05
22.0	0.101E+07	0.215E+04	0.104E+06
24.0	0.116E+07	0.241E+04	0.120E+06

MAPS COMPUTER PROGRAM OUTPUT

MAXIMUM FLOW- STAGE 1	0.150E+01 MGD
AVERAGE FLOW- STAGE 1	0.150E+01 MGD
LENGTH	0.100E+05 FT
LENGTH	0.189E+01 MI
INITIAL ELEVATION	0.120E+03 FT
INITIAL PRESSURE HEAD	0.138E+03 FT
FINAL ELEVATION	0.300E+02 FT
FINAL PRESSURE HEAD	0.138E+03 FT
ROUGHNESS HEIGHT	0.400E-03 FT
ALLOWABLE PRESSURE IN PIPE	0.400E+03 FT
RECTANGULAR TRENCH	
DEPTH OF COVER	0.300E+01 FT
DRY SOIL CONDITIONS	
ROCK EXCAVATION	0.200E+02 %
TYPE OF PIPE	
DUCTILE IRON PIPE IS USED FOR ALL DIAMETERS	

**HEAD REQUIREMENTS ARE BASED ON FLOWS SUPPLIED BY USER--AN ADJUSTED FLOW RATE HAS BEEN COMPUTED BASED SOLELY ON DROP IN ELEVATION--
NO PUMPING

HYDRAULIC ANALYSIS AT PEAK FLOW (FIRST STAGE)
1.736 CFS 1.500 MGD

DIAM (IN)	VELOCITY (FPS)	VELOCITY HEAD (FT)	MINOR LOSSES (FT)	FRICTION LOSSES (FT)	HEAD REQUIRED (FT)	NO PUMP FLOW (CFS)
6.0	0.758E+01	0.959E+00	0.000E+00	0.295E+03	0.205E+03	0.151E+01
8.0	0.411E+01	0.262E+00	0.000E+00	0.949E+02	0.490E-01	0.171E+01
10.0	0.255E+01	0.101E+00	0.000E+00	0.378E+02	-.522E+02	0.437E+01
12.0	0.[illegible]07E+01	0.[illegible]05E+00	0.000E+00	0.174E+02	-.726E+02	0.655E+01
16.0	0.144E+01	0.618E-01	0.000E+00	0.392E+01	-.811E+02	0.930E+01
18.0	0.154E+01	0.386E-01	0.000E+00	0.497E+01	-.850E+02	0.127E+02
20.0	0.138E+01	0.253E-01	0.000E+00	0.295E+01	-.871E+02	0.167E+02
24.0	0.105E+01	0.173E-01	0.000E+00	0.184E+01	-.882E+02	0.214E+02
24.0	0.836E+00	0.[illegible]02E-01	0.000E+00	0.120E+01	-.888E+02	0.270E+02

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 3

CONSTRUCTION YEAR-STAGE 1	1990	
INTEREST RATE	10.000	%
DESIGN LIFE	50	YEARS
ENR CONSTRUCTION INDEX	4400.7	
LAND COST	0.000E+00	$
CITY MULTIPLIER	1.000	
TERRAIN TYPE--		

DIAM (IN)	PIPE COSTS ($)	OTHER COSTS ($)	CONSTRUCTION COSTS ($)	OVERHEAD COSTS ($)	OPERATION & MAINT. ($/YR)
8.0	0.1839E+06	0.5263E+05	0.2365E+06	0.5912E+05	0.9452E+03
10.0	0.2296E+06	0.6395E+05	0.2935E+06	0.7339E+05	0.1049E+04
12.0	0.2753E+06	0.7538E+05	0.3507E+06	0.8767E+05	0.1155E+04
14.0	0.3210E+06	0.8693E+05	0.4079E+06	0.1020E+06	0.1262E+04
16.0	0.3666E+06	0.9860E+05	0.4652E+06	0.1163E+06	0.1369E+04
18.0	0.4247E+06	0.1129E+06	0.5375E+06	0.1344E+06	0.1519E+04
20.0	0.4974E+06	0.1302E+06	0.6277E+06	0.1569E+06	0.1714E+04
22.0	0.5739E+06	0.1484E+06	0.7224E+06	0.1806E+06	0.1918E+04
24.0	0.6540E+06	0.1765E+06	0.8305E+06	0.2076E+06	0.2152E+04

FORCE MAIN COST SUMMARY
MOD NO. 3

DIAM (IN)	CAPITAL COST ($)	O&M COST ($/YR)	AVERAGE ANNUAL COST ($/YR)
8.0	0.296E+06	0.945E+03	0.308E+05
10.0	0.367E+06	0.105E+04	0.381E+05
12.0	0.438E+06	0.116E+04	0.454E+05
14.0	0.510E+06	0.126E+04	0.527E+05
16.0	0.582E+06	0.137E+04	0.600E+05
18.0	0.672E+06	0.152E+04	0.693E+05
20.0	0.785E+06	0.171E+04	0.808E+05
22.0	0.903E+06	0.192E+04	0.930E+05
24.0	0.104E+07	0.215E+04	0.107E+06

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 4

MAXIMUM FLOW- STAGE 1	0.434E+01	MGD
AVERAGE FLOW- STAGE 1	0.434E+01	MGD
LENGTH	0.198E+05	FT
LENGTH	0.375E+01	MI
INITIAL ELEVATION	0.400E+02	FT
INITIAL PRESSURE HEAD	0.000E+00	FT
FINAL ELEVATION	0.500E+02	FT
FINAL PRESSURE HEAD	0.138E+03	FT
PEAK ELEVATION	0.850E+02	FT
DISTANCE TO PEAK	0.162E+05	FT
ROUGHNESS HEIGHT	0.400E-03	FT
ALLOWABLE PRESSURE IN PIPE	0.600E+03	FT
RECTANGULAR TRENCH		
DEPTH OF COVER	0.300E+01	FT
DRY SOIL CONDITIONS		
ROCK EXCAVATION	0.200E+02	%
TYPE OF PIPE		

DUCTILE IRON PIPE IS USED FOR ALL DIAMETERS

HYDRAULIC ANALYSIS AT PEAK FLOW (FIRST STAGE)
6.714 CFS 4.340 MGD

DIAM (IN)	VELOCITY (FPS)	VELOCITY HEAD (FT)	MINOR LOSSES (FT)	FRICTION LOSSES (FT)	HEAD REQUIRED (FT)
8.0	0.192E+02	0.575E+01	0.000E+00	0.327E+04	0.342E+04
10.0	0.123E+02	0.236E+01	0.000E+00	0.104E+04	0.119E+04
12.0	0.855E+01	0.114E+01	0.000E+00	0.409E+03	0.557E+03
14.0	0.628E+01	0.613E+00	0.000E+00	0.186E+03	0.334E+03
16.0	0.481E+01	0.359E+00	0.000E+00	0.947E+02	0.243E+03
18.0	0.380E+01	0.224E+00	0.000E+00	0.522E+02	0.200E+03
20.0	0.308E+01	0.147E+00	0.000E+00	0.307E+02	0.179E+03
22.0	0.254E+01	0.101E+00	0.000E+00	0.191E+02	0.167E+03
24.0	0.214E+01	0.710E-01	0.000E+00	0.123E+02	0.160E+03

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 4		
CONSTRUCTION YEAR-STAGE 1	1990	
INTEREST RATE	10.000	%
DESIGN LIFE	50	YEARS
ENR CONSTRUCTION INDEX	4400.7	
LAND COST	0.000E+00	$
CITY MULTIPLIER	1.000	
TERRAIN TYPE--		

DIAM (IN)	PIPE COSTS ($)	OTHER COSTS ($)	CONSTRUCTION COSTS ($)	OVERHEAD COSTS ($)	OPERATION & MAINT. ($/YR)
8.0	0.3640E+06	0.1042E+06	0.4682E+06	0.1171E+06	0.1871E+04
10.0	0.4546E+06	0.1266E+06	0.5812E+06	0.1453E+06	0.2078E+04
12.0	0.5451E+06	0.1492E+06	0.6944E+06	0.1736E+06	0.2287E+04
14.0	0.6355E+06	0.1721E+06	0.8077E+06	0.2019E+06	0.2498E+04
16.0	0.7259E+06	0.1952E+06	0.9212E+06	0.2303E+06	0.2710E+04
18.0	0.8409E+06	0.2235E+06	0.1064E+07	0.2661E+06	0.3007E+04
20.0	0.9849E+06	0.2578E+06	0.1243E+07	0.3107E+06	0.3394E+04
22.0	0.1136E+07	0.2939E+06	0.1430E+07	0.3576E+06	0.3797E+04
24.0	0.1295E+07	0.3494E+06	0.1644E+07	0.4111E+06	0.4260E+04

FORCE MAIN COST SUMMARY
MOD NO. 4

DIAM (IN)	CAPITAL COST ($)	O&M COST ($/YR)	AVERAGE ANNUAL COST ($/YR)
8.0	0.585E+06	0.187E+04	0.609E+05
10.0	0.727E+06	0.208E+04	0.754E+05
12.0	0.868E+06	0.229E+04	0.898E+05
14.0	0.101E+07	0.250E+04	0.104E+06
16.0	0.115E+07	0.271E+04	0.119E+06
18.0	0.133E+07	0.301E+04	0.137E+06
20.0	0.155E+07	0.339E+04	0.160E+06
22.0	0.179E+07	0.380E+04	0.184E+06
24.0	0.206E+07	0.426E+04	0.212E+06

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 5		
MAXIMUM FLOW- STAGE 1	0.204E+01	MGD
AVERAGE FLOW- STAGE 1	0.204E+01	MGD
LENGTH	0.120E+05	FT
LENGTH	0.227E+01	MI
INITIAL ELEVATION	0.500E+02	FT
INITIAL PRESSURE HEAD	0.138E+03	FT
FINAL ELEVATION	0.100E+03	FT
FINAL PRESSURE HEAD	0.138E+03	FT
ROUGHNESS HEIGHT	0.400E-03	FT
ALLOWABLE PRESSURE IN PIPE	0.400E+03	FT
RECTANGULAR TRENCH		
DEPTH OF COVER	0.300E+01	FT
DRY SOIL CONDITIONS		
ROCK EXCAVATION	0.200E+02	%
TYPE OF PIPE		
DUCTILE IRON PIPE IS USED FOR ALL DIAMETERS		

HYDRAULIC ANALYSIS AT PEAK FLOW (FIRST STAGE)
3.156 CFS 2.040 MGD

DIAM (IN)	VELOCITY (FPS)	VELOCITY HEAD (FT)	MINOR LOSSES (FT)	FRICTION LOSSES (FT)	HEAD REQUIRED (FT)
8.0	0.904E+01	0.127E+01	0.000E+00	0.452E+03	0.502E+03
10.0	0.579E+01	0.520E+00	0.000E+00	0.145E+03	0.195E+03
12.0	0.402E+01	0.251E+00	0.000E+00	0.576E+02	0.108E+03
14.0	0.295E+01	0.135E+00	0.000E+00	0.265E+02	0.765E+02
16.0	0.226E+01	0.794E-01	0.000E+00	0.136E+02	0.636E+02
18.0	0.179E+01	0.496E-01	0.000E+00	0.754E+01	0.575E+02
20.0	0.145E+01	0.325E-01	0.000E+00	0.447E+01	0.545E+02
22.0	0.120E+01	0.222E-01	0.000E+00	0.279E+01	0.528E+02
24.0	0.100E+01	0.157E-01	0.000E+00	0.182E+01	0.518E+02

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 5

CONSTRUCTION YEAR-STAGE 1	1990	
INTEREST RATE	10.000	%
DESIGN LIFE	50	YEARS
ENR CONSTRUCTION INDEX	4400.7	
LAND COST	0.000E+00	$
CITY MULTIPLIER	1.000	
TERRAIN TYPE--		

DIAM (IN)	PIPE COSTS ($)	OTHER COSTS ($)	CONSTRUCTION COSTS ($)	OVERHEAD COSTS ($)	OPERATION & MAINT. ($/YR)
8.0	0.2206E+06	0.6316E+05	0.2838E+06	0.7095E+05	0.1134E+04
10.0	0.2755E+06	0.7674E+05	0.3523E+06	0.8806E+05	0.1259E+04
12.0	0.3304E+06	0.9045E+05	0.4208E+06	0.1052E+06	0.1386E+04
14.0	0.3852E+06	0.1043E+06	0.4895E+06	0.1224E+06	0.1514E+04
16.0	0.4400E+06	0.1183E+06	0.5583E+06	0.1396E+06	0.1643E+04
18.0	0.5096E+06	0.1354E+06	0.6451E+06	0.1613E+06	0.1822E+04
20.0	0.5969E+06	0.1563E+06	0.7532E+06	0.1883E+06	0.2057E+04
22.0	0.6887E+06	0.1781E+06	0.8668E+06	0.2167E+06	0.2301E+04
24.0	0.7848E+06	0.2118E+06	0.9966E+06	0.2491E+06	0.2582E+04

FORCE MAIN COST SUMMARY

MOD NO. 5

DIAM (IN)	CAPITAL COST ($)	O&M COST ($/YR)	AVERAGE ANNUAL COST ($/YR)
8.0	0.355E+06	0.113E+04	0.369E+05
10.0	0.440E+06	0.126E+04	0.457E+05
12.0	0.526E+06	0.139E+04	0.544E+05
14.0	0.612E+06	0.151E+04	0.632E+05
16.0	0.698E+06	0.164E+04	0.720E+05
18.0	0.806E+06	0.182E+04	0.831E+05
20.0	0.941E+06	0.206E+04	0.970E+05
22.0	0.108E+07	0.230E+04	0.112E+06
24.0	0.125E+07	0.258E+04	0.128E+06

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 6		
MAXIMUM FLOW- STAGE 1	0.156E+01	MGD
AVERAGE FLOW- STAGE 1	0.156E+01	MGD
LENGTH	0.204E+05	FT
LENGTH	0.386E+01	MI
INITIAL ELEVATION	0.100E+03	FT
INITIAL PRESSURE HEAD	0.138E+03	FT
FINAL ELEVATION	0.140E+03	FT
FINAL PRESSURE HEAD	0.138E+03	FT
ROUGHNESS HEIGHT	0.400E-03	FT
ALLOWABLE PRESSURE IN PIPE	0.400E+03	FT
RECTANGULAR TRENCH		
DEPTH OF COVER	0.300E+01	FT
DRY SOIL CONDITIONS		
ROCK EXCAVATION	0.200E+02	%
TYPE OF PIPE		
DUCTILE IRON PIPE IS USED FOR ALL DIAMETERS		

HYDRAULIC ANALYSIS AT PEAK FLOW (FIRST STAGE)
2.413 CFS 1.560 MGD

DIAM (IN)	VELOCITY (FPS)	VELOCITY HEAD (FT)	MINOR LOSSES (FT)	FRICTION LOSSES (FT)	HEAD REQUIRED (FT)
8.0	0.691E+01	0.743E+00	0.000E+00	0.456E+03	0.496E+03
10.0	0.442E+01	0.304E+00	0.000E+00	0.147E+03	0.187E+03
12.0	0.307E+01	0.147E+00	0.000E+00	0.586E+02	0.986E+02
14.0	0.226E+01	0.792E-01	0.000E+00	0.271E+02	0.671E+02
16.0	0.173E+01	0.464E-01	0.000E+00	0.139E+02	0.539E+02
18.0	0.137E+01	0.290E-01	0.000E+00	0.775E+01	0.477E+02
20.0	0.111E+01	0.190E-01	0.000E+00	0.460E+01	0.446E+02
22.0	0.914E+00	0.130E-01	0.000E+00	0.288E+01	0.429E+02
24.0	0.768E+00	0.917E-02	0.000E+00	0.188E+01	0.419E+02

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 6

CONSTRUCTION YEAR-STAGE 1	1990	
INTEREST RATE	10.000	%
DESIGN LIFE	50	YEARS
ENR CONSTRUCTION INDEX	4400.7	
LAND COST	0.000E+00	$
CITY MULTIPLIER	1.000	
TERRAIN TYPE--		

DIAM (IN)	PIPE COSTS ($)	OTHER COSTS ($)	CONSTRUCTION COSTS ($)	OVERHEAD COSTS ($)	OPERATION & MAINT. ($/YR)
8.0	0.3751E+06	0.1074E+06	0.4824E+06	0.1206E+06	0.1928E+04
10.0	0.4684E+06	0.1305E+06	0.5988E+06	0.1497E+06	0.2141E+04
12.0	0.5616E+06	0.1538E+06	0.7154E+06	0.1788E+06	0.2356E+04
14.0	0.6548E+06	0.1773E+06	0.8321E+06	0.2080E+06	0.2574E+04
16.0	0.7479E+06	0.2011E+06	0.9491E+06	0.2373E+06	0.2792E+04
18.0	0.8663E+06	0.2303E+06	0.1097E+07	0.2741E+06	0.3098E+04
20.0	0.1015E+07	0.2656E+06	0.1280E+07	0.3201E+06	0.3497E+04
22.0	0.1171E+07	0.3028E+06	0.1474E+07	0.3684E+06	0.3912E+04
24.0	0.1334E+07	0.3600E+06	0.1694E+07	0.4236E+06	0.4389E+04

FORCE MAIN COST SUMMARY
MOD NO. 6

DIAM (IN)	CAPITAL COST ($)	O&M COST ($/YR)	AVERAGE ANNUAL COST ($/YR)
8.0	0.603E+06	0.193E+04	0.628E+05
10.0	0.749E+06	0.214E+04	0.776E+05
12.0	0.894E+06	0.236E+04	0.925E+05
14.0	0.104E+07	0.257E+04	0.107E+06
16.0	0.119E+07	0.279E+04	0.122E+06
18.0	0.137E+07	0.310E+04	0.141E+06
20.0	0.160E+07	0.350E+04	0.165E+06
22.0	0.184E+07	0.391E+04	0.190E+06
24.0	0.212E+07	0.439E+04	0.218E+06

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 7

MAXIMUM FLOW- STAGE 1	0.130E+01	MGD
AVERAGE FLOW- STAGE 1	0.130E+01	MGD
LENGTH	0.118E+05	FT
LENGTH	0.223E+01	MI
INITIAL ELEVATION	0.140E+03	FT
INITIAL PRESSURE HEAD	0.138E+03	FT
FINAL ELEVATION	0.206E+03	FT
FINAL PRESSURE HEAD	0.138E+03	FT
ROUGHNESS HEIGHT	0.400E-03	FT
ALLOWABLE PRESSURE IN PIPE	0.400E+03	FT
RECTANGULAR TRENCH		
DEPTH OF COVER	0.300E+01	FT
DRY SOIL CONDITIONS		
ROCK EXCAVATION	0.200E+02	%
TYPE OF PIPE		
DUCTILE IRON PIPE IS USED FOR ALL DIAMETERS		

HYDRAULIC ANALYSIS AT PEAK FLOW (FIRST STAGE)
2.011 CFS 1.300 MGD

DIAM (IN)	VELOCITY (FPS)	VELOCITY HEAD (FT)	MINOR LOSSES (FT)	FRICTION LOSSES (FT)	HEAD REQUIRED (FT)
8.0	0.576E+01	0.516E+00	0.000E+00	0.186E+03	0.252E+03
10.0	0.369E+01	0.211E+00	0.000E+00	0.599E+02	0.126E+03
12.0	0.256E+01	0.102E+00	0.000E+00	0.240E+02	0.900E+02
14.0	0.188E+01	0.550E-01	0.000E+00	0.111E+02	0.771E+02
16.0	0.144E+01	0.322E-01	0.000E+00	0.571E+01	0.717E+02
18.0	0.114E+01	0.201E-01	0.000E+00	0.319E+01	0.692E+02
20.0	0.922E+00	0.132E-01	0.000E+00	0.190E+01	0.679E+02
22.0	0.762E+00	0.902E-02	0.000E+00	0.119E+01	0.672E+02
24.0	0.640E+00	0.637E-02	0.000E+00	0.778E+00	0.668E+02

MAPS COMPUTER PROGRAM OUTPUT

MAIN NO. 7

CONSTRUCTION YEAR-STAGE 1	1990	
INTEREST RATE	10.000	%
DESIGN LIFE	50	YEARS
ENR CONSTRUCTION INDEX	4400.7	
LAND COST	0.000E+00	$
CITY MULTIPLIER	1.000	
TERRAIN TYPE--		

DIAM (IN)	PIPE COSTS ($)	OTHER COSTS ($)	CONSTRUCTION COSTS ($)	OVERHEAD COSTS ($)	OPERATION & MAINT. ($/YR)
8.0	0.2169E+06	0.6211E+05	0.2791E+06	0.6976E+05	0.1115E+04
10.0	0.2709E+06	0.7546E+05	0.3464E+06	0.8660E+05	0.1238E+04
12.0	0.3249E+06	0.8895E+05	0.4138E+06	0.1035E+06	0.1363E+04
14.0	0.3788E+06	0.1026E+06	0.4813E+06	0.1203E+06	0.1489E+04
16.0	0.4326E+06	0.1163E+06	0.5490E+06	0.1372E+06	0.1615E+04
18.0	0.5011E+06	0.1332E+06	0.6343E+06	0.1586E+06	0.1792E+04
20.0	0.5870E+06	0.1537E+06	0.7406E+06	0.1852E+06	0.2023E+04
22.0	0.6773E+06	0.1751E+06	0.8524E+06	0.2131E+06	0.2263E+04
24.0	0.7717E+06	0.2082E+06	0.9800E+06	0.2450E+06	0.2539E+04

FORCE MAIN COST SUMMARY
MOD NO. 7

DIAM (IN)	CAPITAL COST ($)	O&M COST ($/YR)	AVERAGE ANNUAL COST ($/YR)
8.0	0.349E+06	0.112E+04	0.363E+05
10.0	0.433E+06	0.124E+04	0.449E+05
12.0	0.517E+06	0.136E+04	0.535E+05
14.0	0.602E+06	0.149E+04	0.622E+05
16.0	0.686E+06	0.162E+04	0.708E+05
18.0	0.793E+06	0.179E+04	0.818E+05
20.0	0.926E+06	0.202E+04	0.954E+05
22.0	0.107E+07	0.226E+04	0.110E+06
24.0	0.122E+07	0.254E+04	0.126E+06

MAPS COMPUTER PROGRAM OUTPUT

PUMP NO. 1	
MAXIMUM FLOW(STAGE 1)	0.362E+01 MGD
AVERAGE FLOW(STAGE 1)	0.362E+01 MGD
REQUIRED HEAD BASED ON FORCE MAIN MOD	1
RAW OR TREATED WATER PUMPING	
YEAR BUILT	1990
DESIGN LIFE	50 YEARS
EFFICIENCY OF PUMP AND MOTOR	0.600E+02 PERCENT
MAXIMUM HEAD PER STATION	0.100E+04 FT
NO. OF STATIONS DETERMINED BY PROGRAM	
NO. PUMPS PER STATION-STAGE 1	2
NO WET WELL	
IMPROVED STRUCTURE	
DOWNTIME	0.0 PERCENT

ECONOMIC OUTPUT

INTEREST RATE	0.100E+02 PERCENT
ENR INDEX	0.440E+04
CITY MULTIPLIER	0.100E+01
O&M WAGE	0.200E+02 $/HR
COST OF ELECTRICITY	0.800E-01 $/KWHR
COST OF LAND SITE IMPROVEMENT	0.000E+00 $

COST OF STRUCTURE AND SWITCHYARD FOR SINGLE STATION
COST BASED ON 3.62 MGD, BUILT IN 1990

DIAM	NO. OF STATIONS	POWER CAPACITY (KVA)	STRUCTURE COSTS ($)	SWITCHYARD COSTS ($)
8.0	2	0.987E+03	0.236E+05	0.000E+00
10.0	1	0.724E+03	0.236E+05	0.000E+00
12.0	1	0.374E+03	0.236E+05	0.000E+00
14.0	1	0.250E+03	0.236E+05	0.000E+00
16.0	1	0.199E+03	0.236E+05	0.000E+00
18.0	1	0.175E+03	0.236E+05	0.000E+00
20.0	1	0.163E+03	0.236E+05	0.000E+00
22.0	1	0.156E+03	0.236E+05	0.000E+00
24.0	1	0.152E+03	0.236E+05	0.000E+00

COSTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT FOR SINGLE STATION
COSTS FOR STAGE 1 BASED ON 0.362E+01 MGD, BUILT IN 1990

DIAM (IN)	HEAD PER STATION (FT)	MECHANIC COST ($)	ELECTRIC COST ($)	MISC COST ($)	CONSTRUCT COST ($)	OVERHEAD COST ($)
8.	0.100E+04	0.233E+06	0.000E+00	0.842E+05	0.443E+06	0.111E+06
10.	0.737E+03	0.196E+06	0.000E+00	0.842E+05	0.394E+06	0.986E+05
12.	0.380E+03	0.135E+06	0.000E+00	0.842E+05	0.316E+06	0.789E+05
14.	0.254E+03	0.108E+06	0.000E+00	0.842E+05	0.280E+06	0.700E+05
16.	0.202E+03	0.946E+05	0.000E+00	0.842E+05	0.263E+06	0.658E+05
18.	0.178E+03	0.881E+05	0.000E+00	0.842E+05	0.255E+06	0.637E+05
20.	0.166E+03	0.846E+05	0.000E+00	0.842E+05	0.250E+06	0.625E+05
22.	0.159E+03	0.827E+05	0.000E+00	0.842E+05	0.248E+06	0.619E+05
24.	0.155E+03	0.816E+05	0.000E+00	0.842E+05	0.246E+06	0.616E+05

MAPS COMPUTER PROGRAM OUTPUT

OPERATION AND MAINTENANCE COSTS FOR SINGLE PUMP STATION
COSTS FOR STAGE 1 BASED ON 0.362E+01 MGD FROM 1990 TO 2040
SUPPLY COST 0.204E+04 $/YR
LABOR COST 0.160E+05 $/YR

DIAM (IN)	HEAD REQUIRED (FT)	POWER REQUIRED (KWHR/YR)	POWER COST ($/YR)	TOTAL O&M ($/YR)
8.0	0.199E+04	0.692E+07	0.554E+06	0.572E+06
10.0	0.727E+03	0.508E+07	0.406E+06	0.424E+06
12.0	0.370E+03	0.262E+07	0.210E+06	0.228E+06
14.0	0.244E+03	0.175E+07	0.140E+06	0.158E+06
16.0	0.192E+03	0.139E+07	0.111E+06	0.129E+06
18.0	0.168E+03	0.123E+07	0.981E+05	0.116E+06
20.0	0.156E+03	0.114E+07	0.913E+05	0.109E+06
22.0	0.149E+03	0.110E+07	0.876E+05	0.106E+06
24.0	0.145E+03	0.107E+07	0.855E+05	0.104E+06

PUMP STATION COST SUMMARY

DIAM (IN)	NO. OF STATIONS	STAGE 1 CAPITAL COST ($)	STAGE 1 O&M COST ($/YR)
8.0	2	0.111E+07	0.114E+07
10.0	1	0.493E+06	0.424E+06
12.0	1	0.394E+06	0.228E+06
14.0	1	0.350E+06	0.158E+06
16.0	1	0.329E+06	0.129E+06
18.0	1	0.318E+06	0.116E+06
20.0	1	0.313E+06	0.109E+06
22.0	1	0.310E+06	0.106E+06
24.0	1	0.308E+06	0.104E+06

MAPS COMPUTER PROGRAM OUTPUT

PUMP NO. 2

MAXIMUM FLOW(STAGE 1)	0.360E+01 MGD
AVERAGE FLOW(STAGE 1)	0.360E+01 MGD
REQUIRED HEAD BASED ON FORCE MAIN MOD	2
RAW OR TREATED WATER PUMPING	
YEAR BUILT	1990
DESIGN LIFE	50 YEARS
EFFICIENCY OF PUMP AND MOTOR	0.600E+02 PERCENT
MAXIMUM HEAD PER STATION	0.100E+04 FT
NO. OF STATIONS DETERMINED BY PROGRAM	
NO. PUMPS PER STATION-STAGE 1	2
NO WET WELL	
IMPROVED STRUCTURE	
DOWNTIME	0.0 PERCENT

ECONOMIC OUTPUT

INTEREST RATE	0.100E+02 PERCENT
ENR INDEX	0.440E+04
CITY MULTIPLIER	0.100E+01
O&M WAGE	0.200E+02 $/HR
COST OF ELECTRICITY	0.800E-01 $/KWHR
COST OF LAND SITE IMPROVEMENT	0.000E+00 $

COST OF STRUCTURE AND SWITCHYARD FOR SINGLE STATION
COST BASED ON 3.60 MGD, BUILT IN 1990

DIAM	NO. OF STATIONS	POWER CAPACITY (KVA)	STRUCTURE COSTS ($)	SWITCHYARD COSTS ($)
8.0	2	0.675E+03	0.236E+05	0.000E+00
10.0	1	0.486E+03	0.236E+05	0.000E+00
12.0	1	0.245E+03	0.236E+05	0.000E+00
14.0	1	0.160E+03	0.236E+05	0.000E+00
16.0	1	0.125E+03	0.236E+05	0.000E+00
18.0	1	0.108E+03	0.236E+05	0.000E+00
20.0	1	0.999E+02	0.236E+05	0.000E+00
22.0	1	0.954E+02	0.236E+05	0.000E+00
24.0	1	0.928E+02	0.236E+05	0.000E+00

COSTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT FOR SINGLE STATION
COSTS FOR STAGE 1 BASED ON 0.360E+01 MGD, BUILT IN 1990

DIAM (IN)	HEAD PER STATION (FT)	MECHANIC COST ($)	ELECTRIC COST ($)	MISC COST ($)	CONSTRUCT COST ($)	OVERHEAD COST ($)
8.	0.690E+03	0.188E+06	0.000E+00	0.840E+05	0.384E+06	0.960E+05
10.	0.498E+03	0.156E+06	0.000E+00	0.840E+05	0.343E+06	0.858E+05
12.	0.251E+03	0.106E+06	0.000E+00	0.840E+05	0.278E+06	0.695E+05
14.	0.163E+03	0.837E+05	0.000E+00	0.840E+05	0.249E+06	0.622E+05
16.	0.127E+03	0.728E+05	0.000E+00	0.840E+05	0.234E+06	0.586E+05
18.	0.111E+03	0.673E+05	0.000E+00	0.840E+05	0.227E+06	0.568E+05
20.	0.102E+03	0.643E+05	0.000E+00	0.840E+05	0.223E+06	0.559E+05
22.	0.976E+02	0.627E+05	0.000E+00	0.840E+05	0.221E+06	0.553E+05
24.	0.949E+02	0.617E+05	0.000E+00	0.840E+05	0.220E+06	0.550E+05

MAPS COMPUTER PROGRAM OUTPUT

OPERATION AND MAINTENANCE COSTS FOR SINGLE PUMP STATION
COSTS FOR STAGE 1 BASED ON 0.360E+01 MGD FROM 1990 TO 2040
SUPPLY COST 0.203E+04 $/YR
LABOR COST 0.160E+05 $/YR

DIAM (IN)	HEAD REQUIRED (FT)	POWER REQUIRED (KWHR/YR)	POWER COST ($/YR)	TOTAL O&M ($/YR)
8.0	0.136E+04	0.473E+07	0.379E+06	0.397E+06
10.0	0.488E+03	0.341E+07	0.273E+06	0.291E+06
12.0	0.241E+03	0.172E+07	0.138E+06	0.156E+06
14.0	0.153E+03	0.112E+07	0.896E+05	0.108E+06
16.0	0.117E+03	0.873E+06	0.699E+05	0.879E+05
18.0	0.101E+03	0.759E+06	0.607E+05	0.787E+05
20.0	0.922E+02	0.700E+06	0.560E+05	0.740E+05
22.0	0.876E+02	0.669E+06	0.535E+05	0.715E+05
24.0	0.849E+02	0.651E+06	0.520E+05	0.700E+05

PUMP STATION COST SUMMARY

DIAM (IN)	NO. OF STATIONS	STAGE 1 CAPITAL COST ($)	STAGE 1 O&M COST ($/YR)
8.0	2	0.960E+06	0.793E+06
10.0	1	0.429E+06	0.291E+06
12.0	1	0.348E+06	0.156E+06
14.0	1	0.311E+06	0.108E+06
16.0	1	0.293E+06	0.879E+05
18.0	1	0.284E+06	0.787E+05
20.0	1	0.279E+06	0.740E+05
22.0	1	0.277E+06	0.715E+05
24.0	1	0.275E+06	0.700E+05

MAPS COMPUTER PROGRAM OUTPUT
PUMP NO. 3

MAXIMUM FLOW(STAGE 1)	0.434E+01 MGD
AVERAGE FLOW(STAGE 1)	0.434E+01 MGD
REQUIRED HEAD BASED ON FORCE MAIN MOD	4
RAW OR TREATED WATER PUMPING	
YEAR BUILT	1990
DESIGN LIFE	50 YEARS
EFFICIENCY OF PUMP AND MOTOR	0.600E+02 PERCENT
MAXIMUM HEAD PER STATION	0.100E+04 FT
NO. OF STATIONS DETERMINED BY PROGRAM	
NO. PUMPS PER STATION-STAGE 1	2
NO WET WELL	
IMPROVED STRUCTURE	
DOWNTIME	0.0 PERCENT

ECONOMIC OUTPUT

INTEREST RATE	0.100E+02 PERCENT
ENR INDEX	0.440E+04
CITY MULTIPLIER	0.100E+01
O&M WAGE	0.200E+02 $/HR
COST OF ELECTRICITY	0.800E-01 $/KWHR
COST OF LAND SITE IMPROVEMENT	0.000E+00 $

COST OF STRUCTURE AND SWITCHYARD FOR SINGLE STATION
COST BASED ON 4.34 MGD, BUILT IN 1990

DIAM	NO. OF STATIONS	POWER CAPACITY (KVA)	STRUCTURE COSTS ($)	SWITCHYARD COSTS ($)
8.0	4	0.102E+04	0.252E+05	0.000E+00
10.0	2	0.711E+03	0.252E+05	0.000E+00
12.0	1	0.668E+03	0.252E+05	0.000E+00
14.0	1	0.406E+03	0.252E+05	0.000E+00
16.0	1	0.298E+03	0.252E+05	0.000E+00
18.0	1	0.248E+03	0.252E+05	0.000E+00
20.0	1	0.222E+03	0.252E+05	0.000E+00
22.0	1	0.209E+03	0.252E+05	0.000E+00
24.0	1	0.201E+03	0.252E+05	0.000E+00

COSTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT FOR SINGLE STATION
COSTS FOR STAGE 1 BASED ON 0.434E+01 MGD, BUILT IN 1990

DIAM (IN)	HEAD PER STATION (FT)	MECHANIC COST ($)	ELECTRIC COST ($)	MISC COST ($)	CONSTRUCT COST ($)	OVERHEAD COST ($)
8.	0.864E+03	0.242E+06	0.000E+00	0.915E+05	0.466E+06	0.117E+06
10.	0.603E+03	0.198E+06	0.000E+00	0.915E+05	0.409E+06	0.102E+06
12.	0.567E+03	0.191E+06	0.000E+00	0.915E+05	0.400E+06	0.999E+05
14.	0.344E+03	0.144E+06	0.000E+00	0.915E+05	0.339E+06	0.848E+05
16.	0.253E+03	0.121E+06	0.000E+00	0.915E+05	0.309E+06	0.773E+05
18.	0.210E+03	0.109E+06	0.000E+00	0.915E+05	0.294E+06	0.735E+05
20.	0.189E+03	0.103E+06	0.000E+00	0.915E+05	0.286E+06	0.714E+05
22.	0.177E+03	0.994E+05	0.000E+00	0.915E+05	0.281E+06	0.702E+05
24.	0.170E+03	0.972E+05	0.000E+00	0.915E+05	0.278E+06	0.695E+05

MAPS COMPUTER PROGRAM OUTPUT

OPERATION AND MAINTENANCE COSTS FOR SINGLE PUMP STATION
COSTS FOR STAGE 1 BASED ON 0.434E+01 MGD FROM 1990 TO 2040
SUPPLY COST 0.241E+04 $/YR
LABOR COST 0.178E+05 $/YR

DIAM (IN)	HEAD REQUIRED (FT)	POWER REQUIRED (KWHR/YR)	POWER COST ($/YR)	TOTAL O&M ($/YR)
8.0	0.342E+04	0.714E+07	0.571E+06	0.591E+06
10.0	0.119E+04	0.498E+07	0.399E+06	0.419E+06
12.0	0.557E+03	0.468E+07	0.375E+06	0.395E+06
14.0	0.334E+03	0.285E+07	0.228E+06	0.248E+06
16.0	0.243E+03	0.209E+07	0.167E+06	0.187E+06
18.0	0.200E+03	0.174E+07	0.139E+06	0.159E+06
20.0	0.179E+03	0.156E+07	0.125E+06	0.145E+06
22.0	0.167E+03	0.146E+07	0.117E+06	0.137E+06
24.0	0.160E+03	0.141E+07	0.113E+06	0.133E+06

PUMP STATION COST SUMMARY

DIAM (IN)	NO. OF STATIONS	STAGE 1 CAPITAL COST ($)	STAGE 1 O&M COST ($/YR)
8.0	4	0.233E+07	0.237E+07
10.0	2	0.102E+07	0.838E+06
12.0	1	0.500E+06	0.395E+06
14.0	1	0.424E+06	0.248E+06
16.0	1	0.387E+06	0.187E+06
18.0	1	0.367E+06	0.159E+06
20.0	1	0.357E+06	0.145E+06
22.0	1	0.351E+06	0.137E+06
24.0	1	0.348E+06	0.133E+06

MAPS COMPUTER PROGRAM OUTPUT

PUMP NO. 4

MAXIMUM FLOW(STAGE 1)	0.204E+01 MGD
AVERAGE FLOW(STAGE 1)	0.204E+01 MGD
REQUIRED HEAD BASED ON FORCE MAIN MOD	5
RAW OR TREATED WATER PUMPING	
YEAR BUILT	1990
DESIGN LIFE	50 YEARS
EFFICIENCY OF PUMP AND MOTOR	0.600E+02 PERCENT
MAXIMUM HEAD PER STATION	0.100E+04 FT
NO. OF STATIONS DETERMINED BY PROGRAM	
NO. PUMPS PER STATION-STAGE 1	2
NO WET WELL	
IMPROVED STRUCTURE	
DOWNTIME	0.0 PERCENT

ECONOMIC OUTPUT

INTEREST RATE	0.100E+02 PERCENT
ENR INDEX	0.440E+04
CITY MULTIPLIER	0.100E+01
O&M WAGE	0.200E+02 $/HR
COST OF ELECTRICITY	0.800E-01 $/KWHR
COST OF LAND SITE IMPROVEMENT	0.000E+00 $

COST OF STRUCTURE AND SWITCHYARD FOR SINGLE STATION

COST BASED ON 2.04 MGD, BUILT IN 1990

DIAM	NO. OF STATIONS	POWER CAPACITY (KVA)	STRUCTURE COSTS ($)	SWITCHYARD COSTS ($)
8.0	1	0.284E+03	0.193E+05	0.000E+00
10.0	1	0.114E+03	0.193E+05	0.000E+00
12.0	1	0.651E+02	0.193E+05	0.000E+00
14.0	1	0.479E+02	0.193E+05	0.000E+00
16.0	1	0.408E+02	0.193E+05	0.000E+00
18.0	1	0.374E+02	0.193E+05	0.000E+00
20.0	1	0.357E+02	0.193E+05	0.000E+00
22.0	1	0.348E+02	0.193E+05	0.000E+00
24.0	1	0.342E+02	0.193E+05	0.000E+00

COSTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT FOR SINGLE STATION

COSTS FOR STAGE 1 BASED ON 0.204E+01 MGD, BUILT IN 1990

DIAM (IN)	HEAD PER STATION (FT)	MECHANIC COST ($)	ELECTRIC COST ($)	MISC COST ($)	CONSTRUCT COST ($)	OVERHEAD COST ($)
8.	0.512E+03	0.108E+06	0.000E+00	0.648E+05	0.250E+06	0.625E+05
10.	0.205E+03	0.647E+05	0.000E+00	0.648E+05	0.193E+06	0.484E+05
12.	0.118E+03	0.473E+05	0.000E+00	0.648E+05	0.171E+06	0.427E+05
14.	0.865E+02	0.398E+05	0.000E+00	0.648E+05	0.161E+06	0.403E+05
16.	0.736E+02	0.364E+05	0.000E+00	0.648E+05	0.157E+06	0.392E+05
18.	0.675E+02	0.347E+05	0.000E+00	0.648E+05	0.154E+06	0.386E+05
20.	0.645E+02	0.338E+05	0.000E+00	0.648E+05	0.153E+06	0.383E+05
22.	0.628E+02	0.333E+05	0.000E+00	0.648E+05	0.153E+06	0.382E+05
24.	0.618E+02	0.330E+05	0.000E+00	0.648E+05	0.152E+06	0.381E+05

MAPS COMPUTER PROGRAM OUTPUT

OPERATION AND MAINTENANCE COSTS FOR SINGLE PUMP STATION
COSTS FOR STAGE 1 BASED ON 0.204E+01 MGD FROM 1990 TO 2040
SUPPLY COST 0.119E+04 $/YR
LABOR COST 0.115E+05 $/YR

DIAM (IN)	HEAD REQUIRED (FT)	POWER REQUIRED (KWHR/YR)	POWER COST ($/YR)	TOTAL O&M ($/YR)
8.0	0.502E+03	0.199E+07	0.159E+06	0.172E+06
10.0	0.195E+03	0.796E+06	0.637E+05	0.764E+05
12.0	0.108E+03	0.457E+06	0.365E+05	0.492E+05
14.0	0.765E+02	0.336E+06	0.269E+05	0.396E+05
16.0	0.636E+02	0.286E+06	0.229E+05	0.355E+05
18.0	0.575E+02	0.262E+06	0.210E+05	0.337E+05
20.0	0.545E+02	0.250E+06	0.200E+05	0.327E+05
22.0	0.528E+02	0.244E+06	0.195E+05	0.322E+05
24.0	0.518E+02	0.240E+06	0.192E+05	0.319E+05

PUMP STATION COST SUMMARY

DIAM (IN)	NO. OF STATIONS	STAGE 1 CAPITAL COST ($)	STAGE 1 O&M COST ($/YR)
8.0	1	0.312E+06	0.172E+06
10.0	1	0.242E+06	0.764E+05
12.0	1	0.214E+06	0.492E+05
14.0	1	0.201E+06	0.396E+05
16.0	1	0.196E+06	0.355E+05
18.0	1	0.193E+06	0.337E+05
20.0	1	0.192E+06	0.327E+05
22.0	1	0.191E+06	0.322E+05
24.0	1	0.190E+06	0.319E+05

MAPS COMPUTER PROGRAM OUTPUT
PUMP NO. 5

MAXIMUM FLOW(STAGE 1)	0.156E+01 MGD
AVERAGE FLOW(STAGE 1)	0.156E+01 MGD
REQUIRED HEAD BASED ON FORCE MAIN MOD	6
RAW OR TREATED WATER PUMPING	
YEAR BUILT	1990
DESIGN LIFE	50 YEARS
EFFICIENCY OF PUMP AND MOTOR	0.600E+02 PERCENT
MAXIMUM HEAD PER STATION	0.100E+04 FT
NO. OF STATIONS DETERMINED BY PROGRAM	
NO. PUMPS PER STATION-STAGE 1	2
NO WET WELL	
IMPROVED STRUCTURE	
DOWNTIME	0.0 PERCENT

ECONOMIC OUTPUT

INTEREST RATE	0.100E+02 PERCENT
ENR INDEX	0.440E+04
CITY MULTIPLIER	0.100E+01
O&M WAGE	0.200E+02 $/HR
COST OF ELECTRICITY	0.800E-01 $/KWHR
COST OF LAND SITE IMPROVEMENT	0.000E+00 $

COST OF STRUCTURE AND SWITCHYARD FOR SINGLE STATION
COST BASED ON 1.56 MGD, BUILT IN 1990

DIAM	NO. OF STATIONS	POWER CAPACITY (KVA)	STRUCTURE COSTS ($)	SWITCHYARD COSTS ($)
8.0	1	0.215E+03	0.176E+05	0.000E+00
10.0	1	0.834E+02	0.176E+05	0.000E+00
12.0	1	0.460E+02	0.176E+05	0.000E+00
14.0	1	0.326E+02	0.176E+05	0.000E+00
16.0	1	0.271E+02	0.176E+05	0.000E+00
18.0	1	0.245E+02	0.176E+05	0.000E+00
20.0	1	0.231E+02	0.176E+05	0.000E+00
22.0	1	0.224E+02	0.176E+05	0.000E+00
24.0	1	0.220E+02	0.176E+05	0.000E+00

COSTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT FOR SINGLE STATION
COSTS FOR STAGE 1 BASED ON 0.156E+01 MGD, BUILT IN 1990

DIAM (IN)	HEAD PER STATION (FT)	MECHANIC COST ($)	ELECTRIC COST ($)	MISC COST ($)	CONSTRUCT COST ($)	OVERHEAD COST ($)
8.	0.506E+03	0.895E+05	0.000E+00	0.573E+05	0.214E+06	0.534E+05
10.	0.197E+03	0.527E+05	0.000E+00	0.573E+05	0.166E+06	0.415E+05
12.	0.109E+03	0.377E+05	0.000E+00	0.573E+05	0.146E+06	0.366E+05
14.	0.771E+02	0.311E+05	0.000E+00	0.573E+05	0.138E+06	0.345E+05
16.	0.639E+02	0.280E+05	0.000E+00	0.573E+05	0.134E+06	0.335E+05
18.	0.577E+02	0.265E+05	0.000E+00	0.573E+05	0.132E+06	0.330E+05
20.	0.546E+02	0.257E+05	0.000E+00	0.573E+05	0.131E+06	0.327E+05
22.	0.529E+02	0.252E+05	0.000E+00	0.573E+05	0.130E+06	0.325E+05
24.	0.519E+02	0.249E+05	0.000E+00	0.573E+05	0.130E+06	0.325E+05

MAPS COMPUTER PROGRAM OUTPUT

OPERATION AND MAINTENANCE COSTS FOR SINGLE PUMP STATION
COSTS FOR STAGE 1 BASED ON 0.156E+01 MGD FROM 1990 TO 2040
SUPPLY COST 0.927E+03 $/YR
LABOR COST 0.984E+04 $/YR

DIAM (IN)	HEAD REQUIRED (FT)	POWER REQUIRED (KWHR/YR)	POWER COST ($/YR)	TOTAL O&M ($/YR)
8.0	0.496E+03	0.150E+07	0.120E+06	0.131E+06
10.0	0.187E+03	0.585E+06	0.468E+05	0.576E+05
12.0	0.986E+02	0.323E+06	0.258E+05	0.366E+05
14.0	0.671E+02	0.229E+06	0.183E+05	0.291E+05
16.0	0.539E+02	0.190E+06	0.152E+05	0.259E+05
18.0	0.477E+02	0.172E+06	0.137E+05	0.245E+05
20.0	0.446E+02	0.162E+06	0.130E+05	0.237E+05
22.0	0.429E+02	0.157E+06	0.126E+05	0.233E+05
24.0	0.419E+02	0.154E+06	0.123E+05	0.231E+05

PUMP STATION COST SUMMARY

DIAM (IN)	NO. OF STATIONS	STAGE 1 CAPITAL COST ($)	STAGE 1 O&M COST ($/YR)
8.0	1	0.267E+06	0.131E+06
10.0	1	0.207E+06	0.576E+05
12.0	1	0.183E+06	0.366E+05
14.0	1	0.172E+06	0.291E+05
16.0	1	0.167E+06	0.259E+05
18.0	1	0.165E+06	0.245E+05
20.0	1	0.163E+06	0.237E+05
22.0	1	0.163E+06	0.233E+05
24.0	1	0.162E+06	0.231E+05

MAPS COMPUTER PROGRAM OUTPUT
PUMP NO. 6 '

MAXIMUM FLOW(STAGE 1)	0.130E+01 MGD
AVERAGE FLOW(STAGE 1)	0.130E+01 MGD
REQUIRED HEAD BASED ON FORCE MAIN MOD	7
RAW OR TREATED WATER PUMPING	
YEAR BUILT	1990
DESIGN LIFE	50 YEARS
EFFICIENCY OF PUMP AND MOTOR	0.600E+02 PERCENT
MAXIMUM HEAD PER STATION	0.100E+04 FT
NO. OF STATIONS DETERMINED BY PROGRAM	
NO. PUMPS PER STATION-STAGE 1	2
NO WET WELL	
IMPROVED STRUCTURE	
DOWNTIME	0.0 PERCENT

ECONOMIC OUTPUT

INTEREST RATE	0.100E+02 PERCENT
ENR INDEX	0.440E+04
CITY MULTIPLIER	0.100E+01
O&M WAGE	0.200E+02 $/HR
COST OF ELECTRICITY	0.800E-01 $/KWHR
COST OF LAND SITE IMPROVEMENT	0.000E+00 $

COST OF STRUCTURE AND SWITCHYARD FOR SINGLE STATION
COST BASED ON 1.30 MGD, BUILT IN 1990

DIAM	NO. OF STATIONS	POWER CAPACITY (KVA)	STRUCTURE COSTS ($)	SWITCHYARD COSTS ($)
8.0	1	0.923E+02	0.165E+05	0.000E+00
10.0	1	0.480E+02	0.165E+05	0.000E+00
12.0	1	0.353E+02	0.165E+05	0.000E+00
14.0	1	0.307E+02	0.165E+05	0.000E+00
16.0	1	0.288E+02	0.165E+05	0.000E+00
18.0	1	0.280E+02	0.165E+05	0.000E+00
20.0	1	0.275E+02	0.165E+05	0.000E+00
22.0	1	0.272E+02	0.165E+05	0.000E+00
24.0	1	0.271E+02	0.165E+05	0.000E+00

COSTS FOR MECHANICAL AND ELECTRICAL EQUIPMENT FOR SINGLE STATION
COSTS FOR STAGE 1 BASED ON 0.130E+01 MGD, BUILT IN 1990

DIAM (IN)	HEAD PER STATION (FT)	MECHANIC COST ($)	ELECTRIC COST ($)	MISC COST ($)	CONSTRUCT COST ($)	OVERHEAD COST ($)
8.	0.262E+03	0.546E+05	0.000E+00	0.527E+05	0.161E+06	0.403E+05
10.	0.136E+03	0.378E+05	0.000E+00	0.527E+05	0.139E+06	0.348E+05
12.	0.100E+03	0.318E+05	0.000E+00	0.527E+05	0.131E+06	0.329E+05
14.	0.871E+02	0.295E+05	0.000E+00	0.527E+05	0.128E+06	0.321E+05
16.	0.817E+02	0.284E+05	0.000E+00	0.527E+05	0.127E+06	0.317E+05
18.	0.792E+02	0.279E+05	0.000E+00	0.527E+05	0.126E+06	0.316E+05
20.	0.779E+02	0.277E+05	0.000E+00	0.527E+05	0.126E+06	0.315E+05
22.	0.772E+02	0.275E+05	0.000E+00	0.527E+05	0.126E+06	0.315E+05
24.	0.768E+02	0.275E+05	0.000E+00	0.527E+05	0.126E+06	0.314E+05

MAPS COMPUTER PROGRAM OUTPUT

OPERATION AND MAINTENANCE COSTS FOR SINGLE PUMP STATION
COSTS FOR STAGE 1 BASED ON 0.130E+01 MGD FROM 1990 TO 2040
SUPPLY COST 0.782E+03 $/YR
LABOR COST 0.885E+04 $/YR

DIAM (IN)	HEAD REQUIRED (FT)	POWER REQUIRED (KWHR/YR)	POWER COST ($/YR)	TOTAL O&M ($/YR)
8.0	0.252E+03	0.647E+06	0.518E+05	0.614E+05
10.0	0.126E+03	0.336E+06	0.269E+05	0.365E+05
12.0	0.900E+02	0.247E+06	0.198E+05	0.294E+05
14.0	0.771E+02	0.216E+06	0.172E+05	0.269E+05
16.0	0.717E+02	0.202E+06	0.162E+05	0.258E+05
18.0	0.692E+02	0.196E+06	0.157E+05	0.253E+05
20.0	0.679E+02	0.193E+06	0.154E+05	0.251E+05
22.0	0.672E+02	0.191E+06	0.153E+05	0.249E+05
24.0	0.668E+02	0.190E+06	0.152E+05	0.248E+05

PUMP STATION COST SUMMARY

DIAM (IN)	NO. OF STATIONS	STAGE 1 CAPITAL COST ($)	STAGE 1 O&M COST ($/YR)
8.0	1	0.201E+06	0.614E+05
10.0	1	0.174E+06	0.365E+05
12.0	1	0.164E+06	0.294E+05
14.0	1	0.160E+06	0.269E+05
16.0	1	0.159E+06	0.258E+05
18.0	1	0.158E+06	0.253E+05
20.0	1	0.158E+06	0.251E+05
22.0	1	0.157E+06	0.249E+05
24.0	1	0.157E+06	0.248E+05